FABRICADEMY
textile and technology academy

#FABRICADEMY2021 TUTORIALS

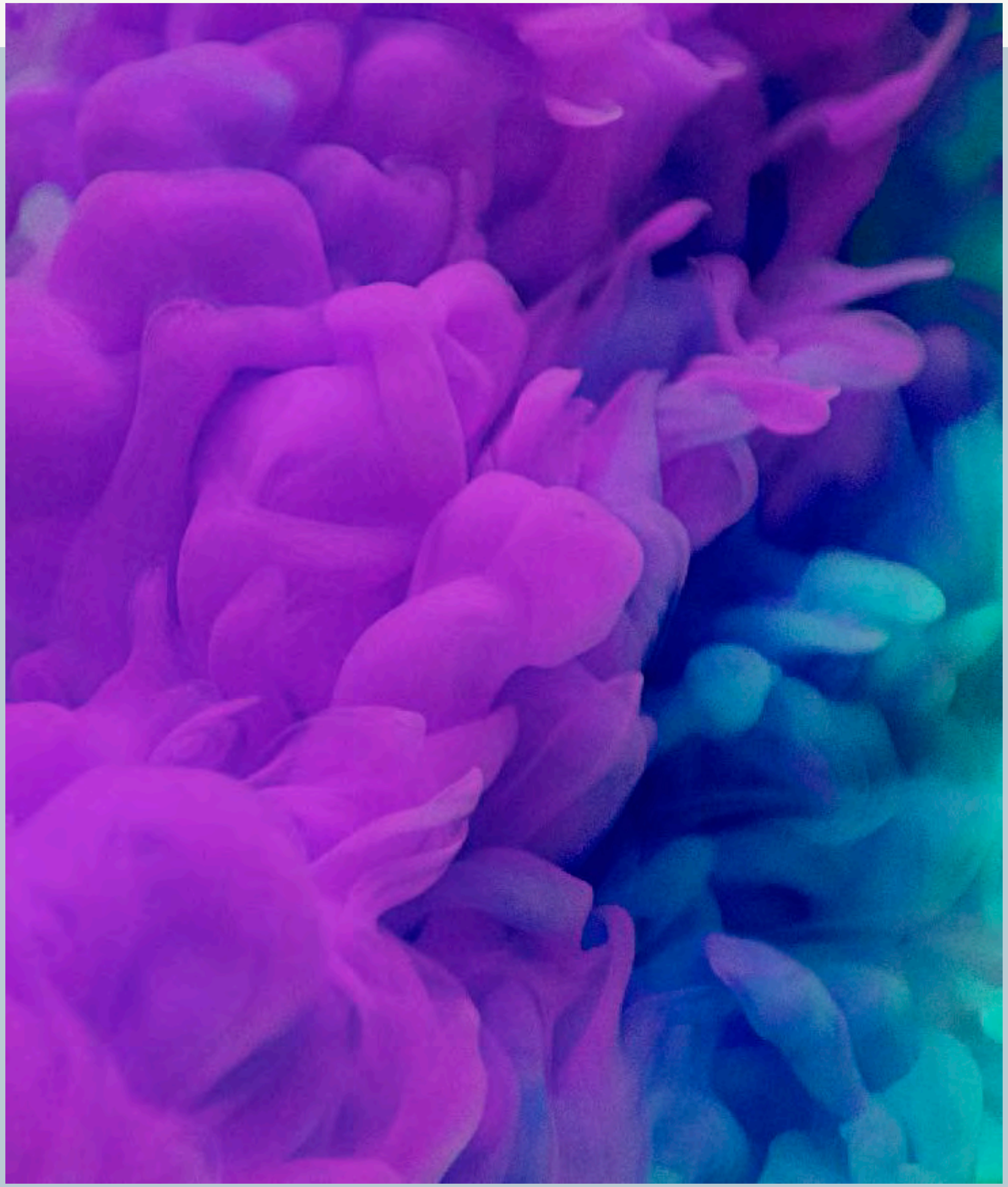
Wet Lab Safety & Concepts

12-10-2021 | Angela Barbour

Safety in Wet Lab

Angela Barbour, Da Escola de Pharmacia, 2018

While laboratories are where miracles happen & discoveries take place, they also pose a risk to the people working in it. This makes managing a laboratory not an easy job. Housing modern Science equipment and facilities in a lab needs advanced safety measures to be undertaken apart from the basic rules that need to be followed. Along with proper lab management, here are some safety tips you need to follow in a laboratory environment:
The following rules are applicable to any generic laboratory



1. Get familiar with the fire rules: You need not wait for a fire to break in your laboratory to educate yourself about the working of a fire alarm & safety signs. These emergency facilities come with instructions that should be on the top of everyone’s mind who work with you in a lab. Train yourself and the people around the emergency facilities available in the building. Keep helpline numbers handy with you.

2. Use warning signs: If your lab contains carcinogens, radioisotopes, biohazards, and lasers, make sure they are properly marked with the correct warning signs. Indicate the exit doors in your lab clearly. Ensure enough ventilation is present in the lab as well.

3. Space out your equipment: Clutter in a laboratory is a sign of potential danger. Keep all equipment at a safe distance from one another. In case of fire sprinklers, keep an area of 36” diameter clear at all times.

4. Check your lab equipment: While conducting experiments it is important to ensure that you are not only working in a safe environment but also using safe apparatus. Check for any chips or cracks in glassware or damaged apparatus and notify the manager immediately.

5. Take precautions while conducting experiments: One of the basic precautions that we have been taught in school is never to lift any glassware, solutions, or other apparatus above eye level. Also don’t smell or taste any chemicals.

6. Do not leave your experiment unattended. Avoid working alone in a lab as well.

7. No incident in a lab is ‘small’: It is crucial to report any small injury, accident or breakage of equipment to the authorities immediately. Even a small error can have a big reaction in a lab.

8. Dispose of chemical waste and equipments carefully: Managing a laboratory is not just limited to handling everything that goes on inside the lab. You need to also ensure that the laboritical waste is disposed of in the correct manner for the safety of people living around.

9. Dress appropriately: Never leave your hair open in a lab. Avoid wearing dangling jewelry or loose clothing around the experiment. Use footwear that covers your feet and do not put acrylic nails when working around Bunsen burners, lighted splints, matches, etc.

10. Use protective measures: Wear face shields or safety glasses & gloves when working on specific equipment. Always wear a smock or a lab coat. Wash your hands before and after eating or leaving a lab.

Lab safety

How can you improve the safety in this lab?
(Four improvements have been highlighted, there are 14 more.)

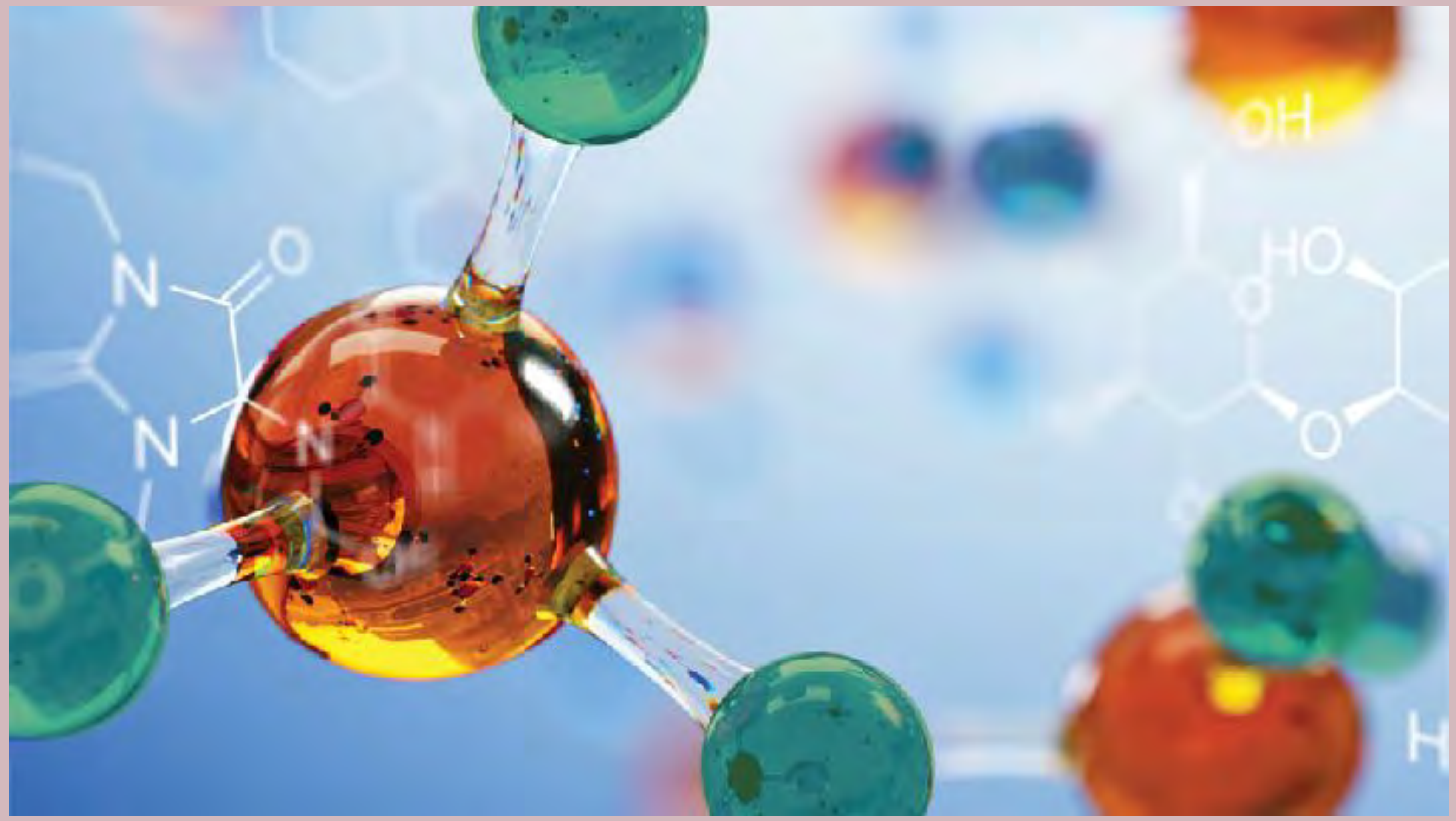
Wet Lab Concepts

Nature is constituted by a huge diversity of substances resulting from the different possibilities of arrangement of the particles that form them: atoms, in an iron bar, in an aluminum frame or in a gold ring, and also in a diamond brilliant or in the graphite from a pencil; molecules, as in water, ethanol and sulfuric acid; ions, in salts.

The species of the particles is the determining factor for the type of interaction force that will occur between them.

Metallic solids

Metals, at room temperature, with the exception of mercury, which is a liquid, are solids formed by crystals – an arrangement of particles with a defined geometric structure.



Ionic solids

At room temperature, ionic compounds are solids with high melting and boiling temperatures and conduct an electric current when melted or dissolved in water. As the chemical species involved are ions – cations and anions – they are bound together by force of electrical character.

Covalent solids

Neutral atoms bound together by covalent bonds, which are generally strong bonds. These atoms form crystals made up of large molecules or macromolecules, as in the case of diamond and graphite. The properties of one another are different due to the spatial distribution of carbon atoms.

Pures Substances

All the particles are the same

Elements

All the atoms are the same

Atoms

particle = atom

Ne

Molecules

particle = 2 or more atoms

O2

Compounds

Elements are the same and chemically combined in a repeating pattern

Molecules

particle = 2 or more atoms with covalent bounds

H20

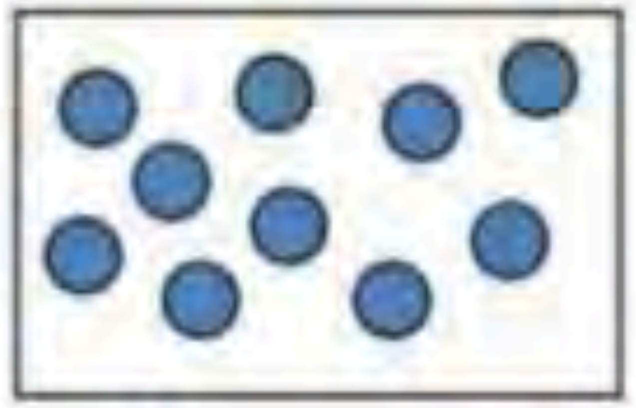
Ions

particle = 2 or more atoms bounded by electrical forces

NaCl

<u>element:</u> **lots of the same atom**

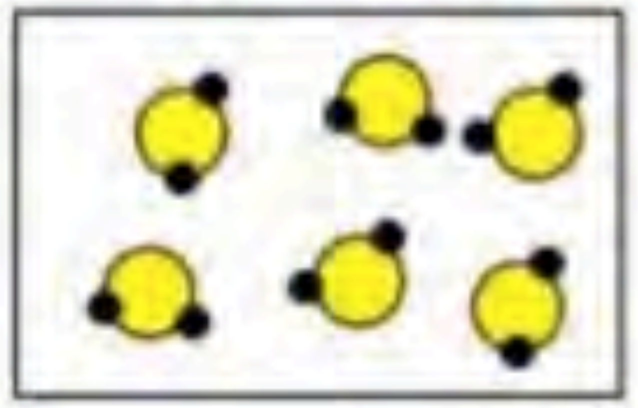
Chemically bound



element

<u>compound:</u>
lots of the same molecule

Chemically bound



compound

<u>mixture</u>

Can be physically separated

mixture

CLASSIFICATION OF MATTER

- Pure Substance
  - Element
    - Carbon C_2
    - Oxygen O_2
  - Compound
    - Salt NaCl
    - Sugar $C_{12}H_{22}O_{11}$
    - Water H_2O
- Mixture
  - Homogeneous Mixture
    - Solution
      - Saltwater
      - $NaCl + H_2O$
    - Alloy
      - Brass $Cu + Zn$
      - Bronze $Cu + Sn$
      - Steel $Fe + C$
  - Heterogeneous Mixture
    - Salad
    - Conglomerate

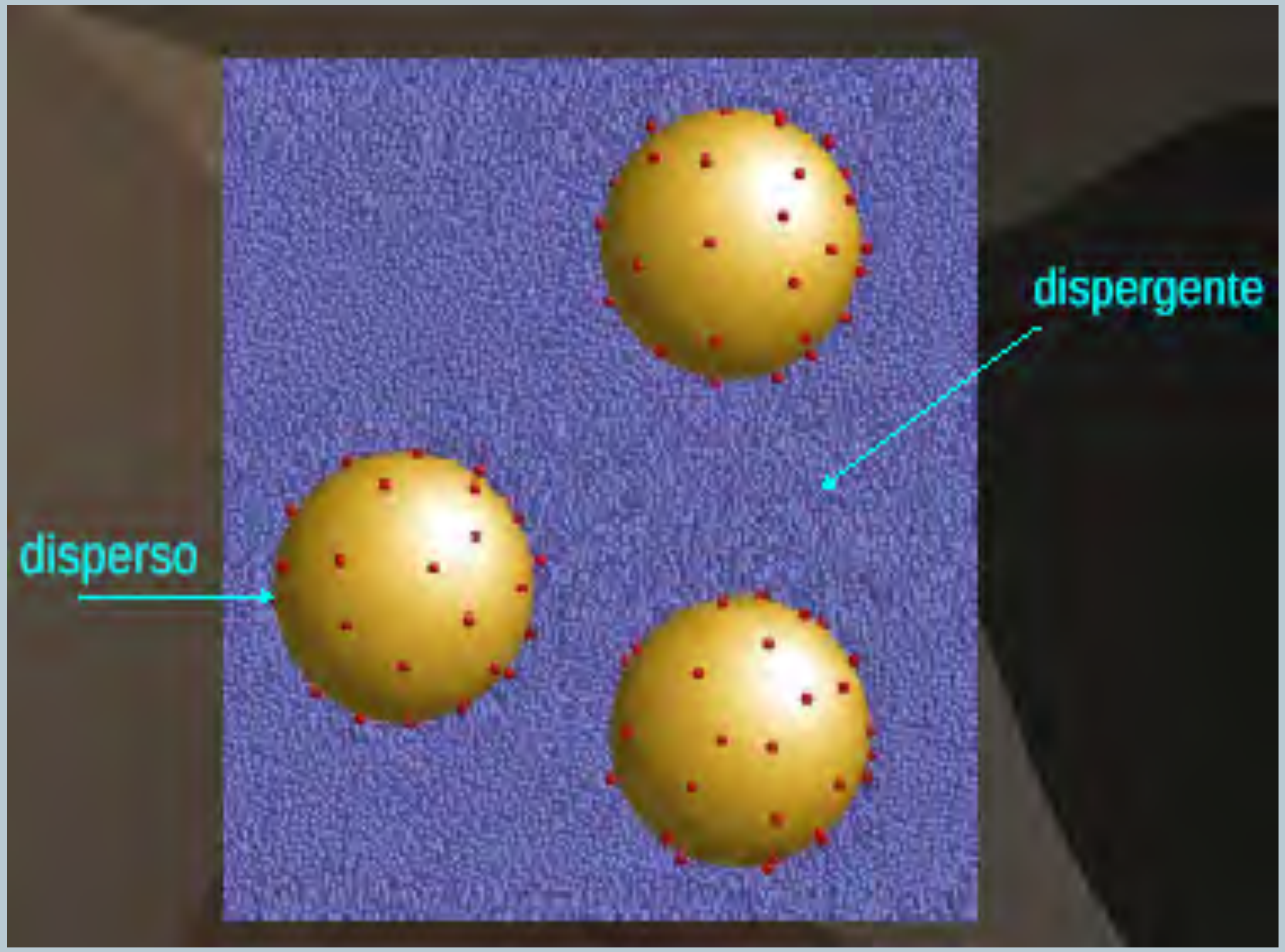

Macaroni Salad
quarter lbs
Bring a large pot of lightly salted water to a boil. Add the macaroni, and cook until tender, about 8 minutes. Rinse under cold water and drain.
In a large bowl, mix together the mayonnaise, vinegar, sugar, mustard, salt and pepper. Stir in the onion, celery, green pepper, carrot, pimentos and macaroni. Refrigerate for at least 4 hours before serving but preferably overnight.
Macaroni
quarter lbs
Mayo
3 oz.
Vinegar
4 oz.
Bell Pepper
4 oz.
Carrot
2 oz.
Celery
5 oz.
Mustard
3 Tbs

cean
Macaroni Salad
Gasoline
WARM SHALLOW WATE
COLD, SALTY DEEP
FIG. 1
FIG. 2
TWO U.S. GALLONS
GASOLINE
DANGER: EXTREMELY FLAMMABLE

Mixtures & Solutions

Types of Mixtures

The mixture of two or more substances can result in distinct systems, which are related to visual perception: one aspect, homogeneous system, two or more aspects, heterogeneous system. In both cases there is one substance dispersed in another. This system is called dispersion; the dispersed substance is the dispersed one (discontinuous phase) and the substance where the other is dispersed is the dispersant (continuous phase).



Suspensions

Mixture in which particles of a material are dispersed throughout a liquid or gas but are large enough that they settle out

muddy water

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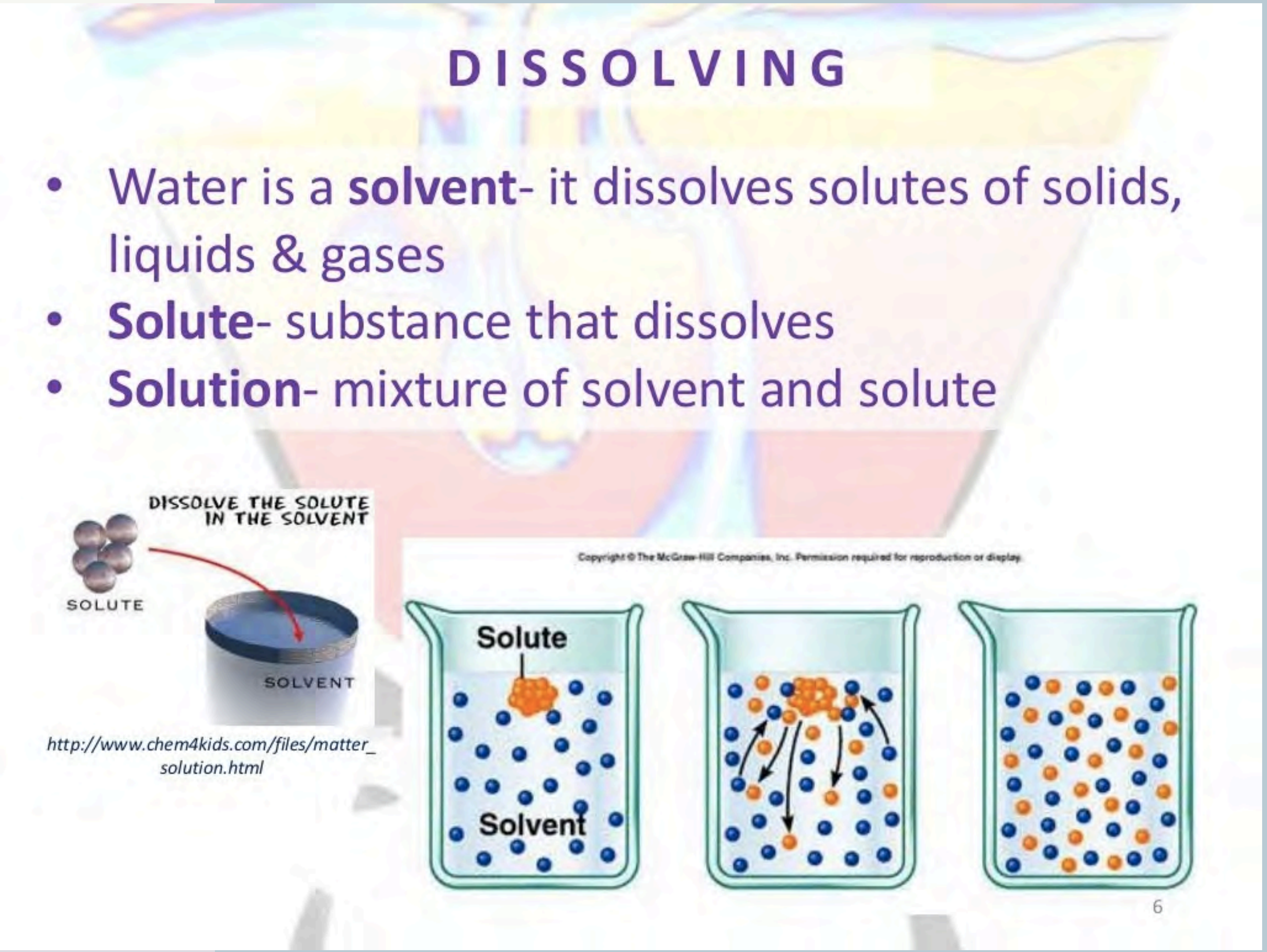
https://www.instagram.com/mattricaria/

Emulsions or Colloids

mixture in which particles are dispersed throughout but are not heavy enough to settle out

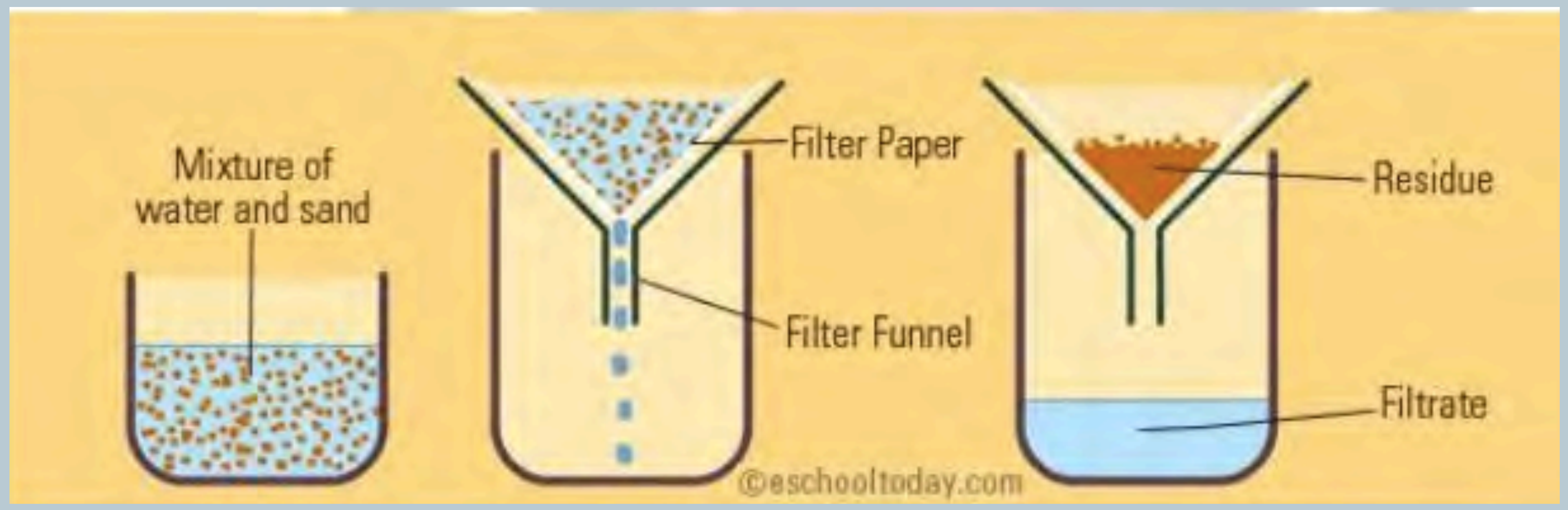
milk, mayonaise, gelatin, whipped cream

Solutions


DISSOLVING
• Water is a **solvent**- it dissolves solutes of solids, liquids & gases
• **Solute**- substance that dissolves
• **Solution**- mixture of solvent and solute
DISSOLVE THE SOLUTE IN THE SOLVENT
SOLUTE
SOLVENT
http://www.chem4kids.com/files/matter_solution.html
Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.
Solute
Solvent
6

Mixtures Separations

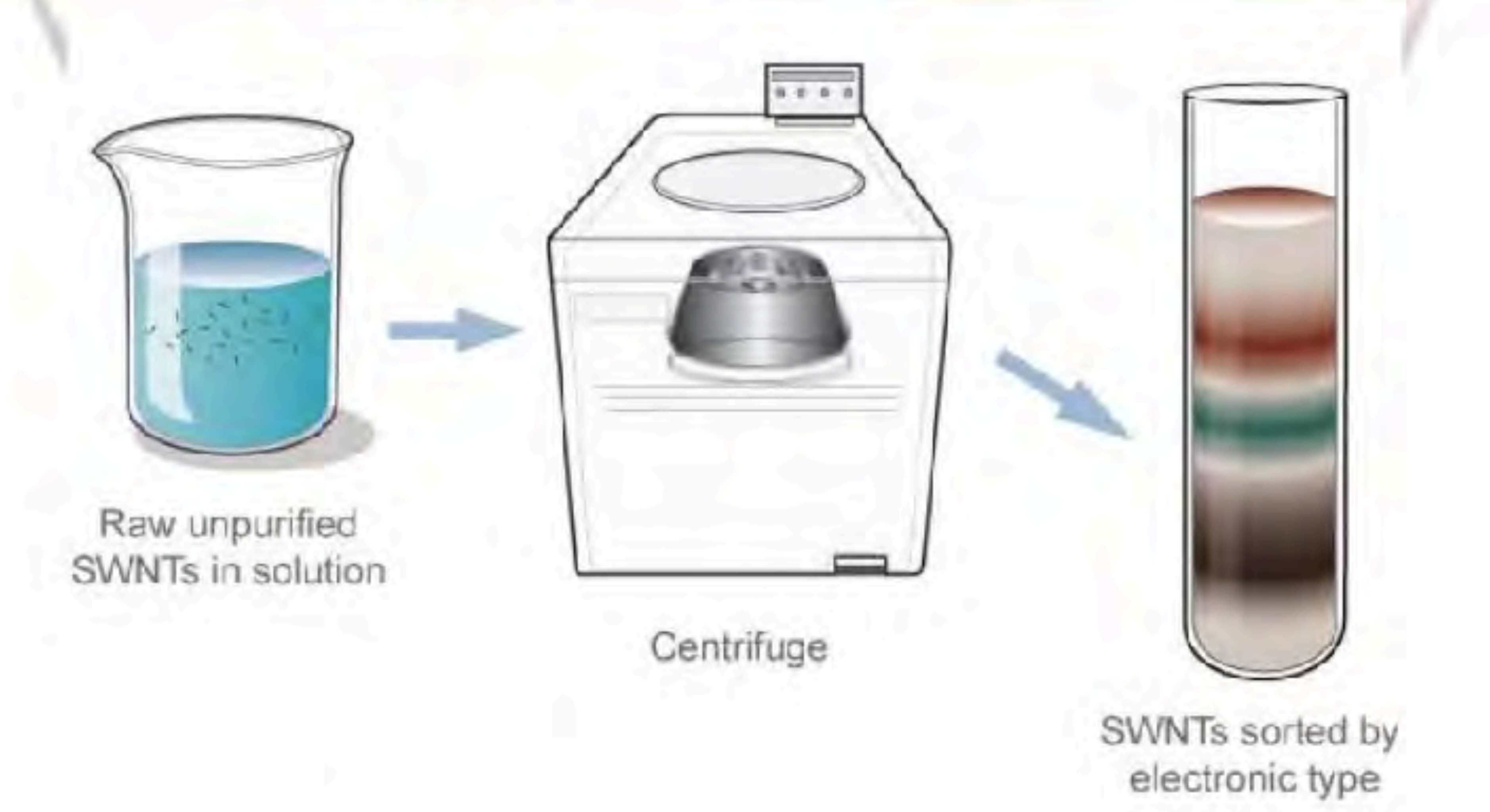
01. Filter - Use a sieve to separate the solvent from larger particles.



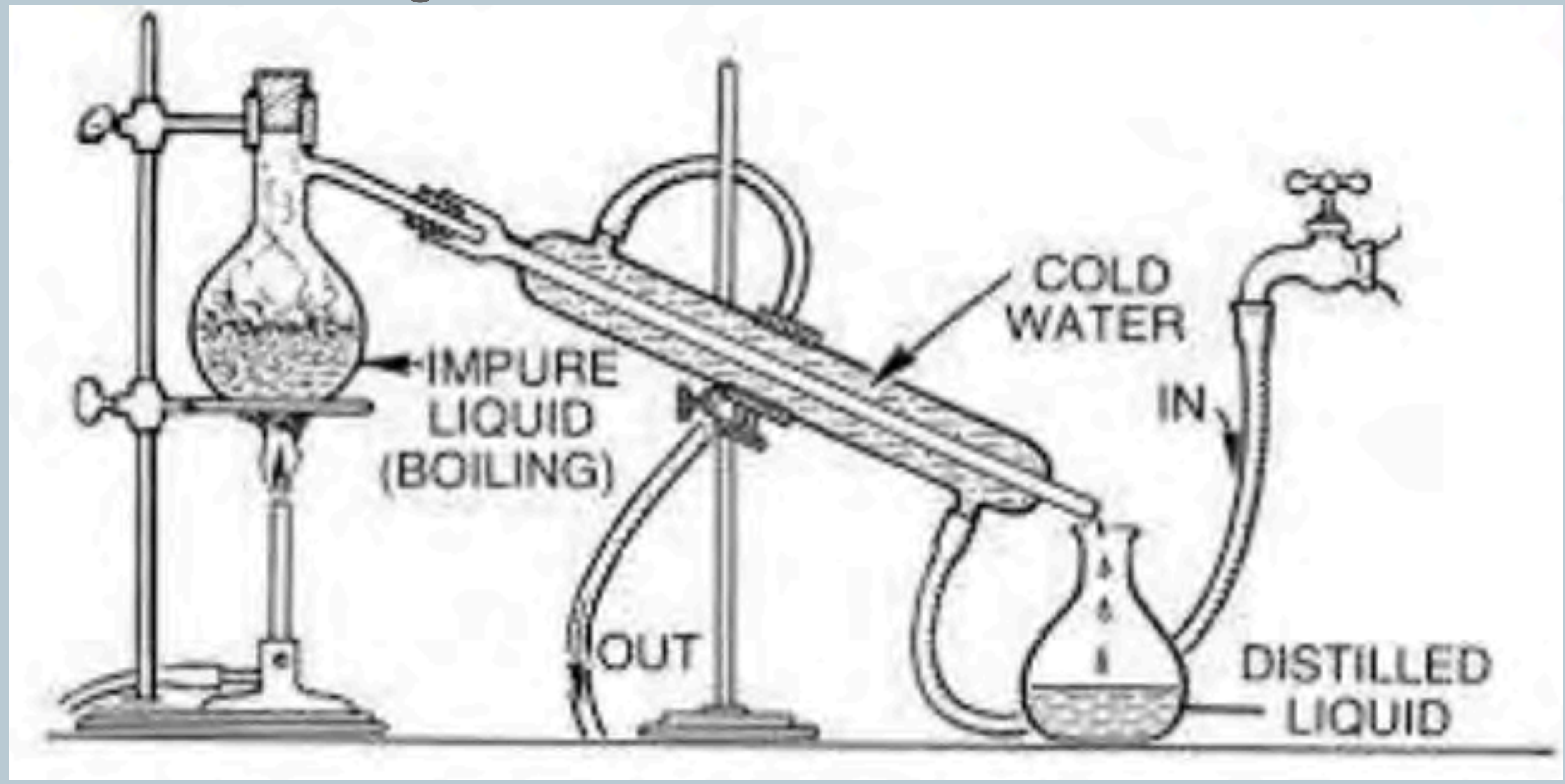
02. Evaporation with the heat , water evaporates and the solute remais.

Mixtures Separations

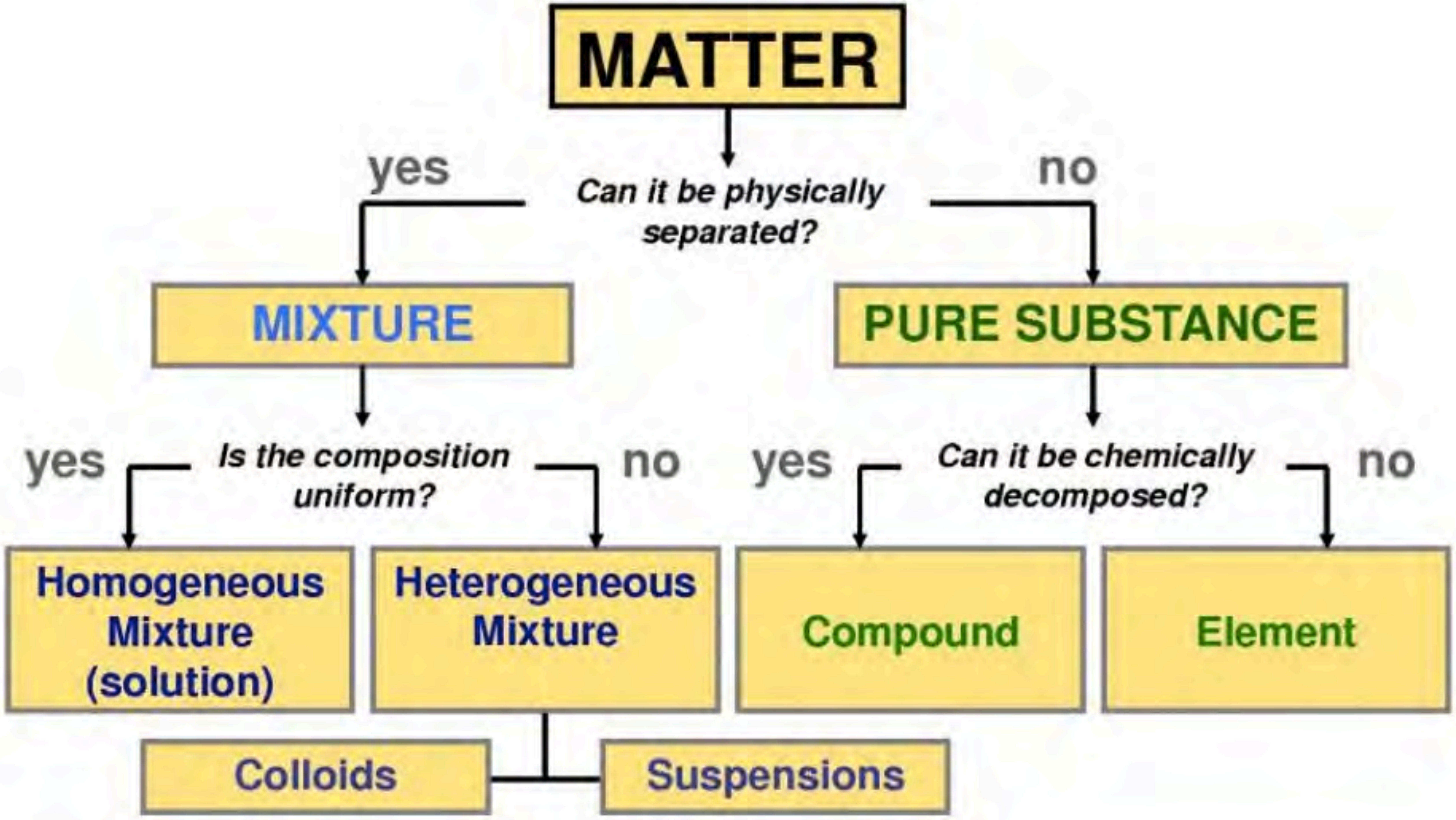
05. Centrifuge. Spinning machines separates parts of a mixture , as blood.



03. Distillation ; separate upon boiling points , as crude oil into gasoline, kerosene.



04. Magnet



MATTER
yes
Can it be physically separated?
no
MIXTURE
PURE SUBSTANCE
yes
Is the composition uniform?
no
yes
Can it be chemically decomposed?
no
Homogeneous Mixture (solution)
Heterogeneous Mixture
Compound
Element
Colloids
Suspensions

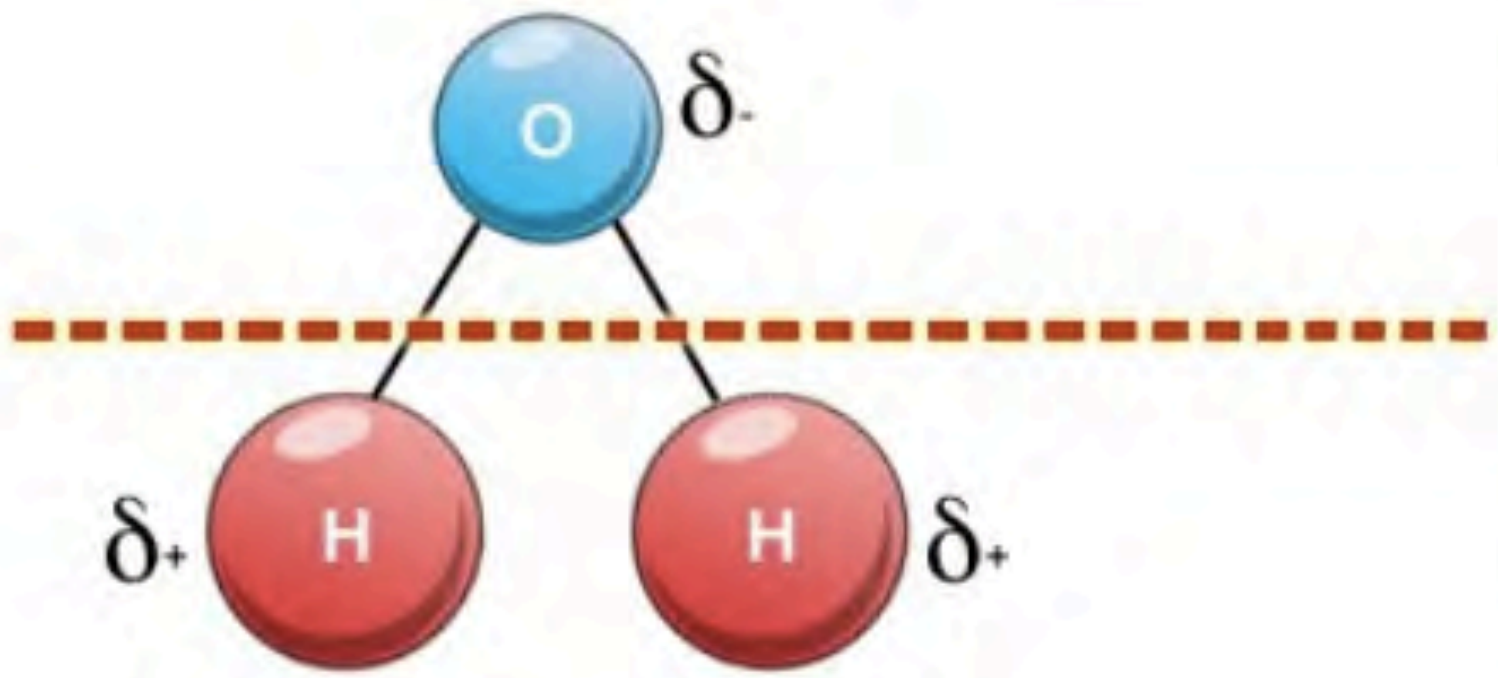
Solutions & Reactions

WATER

- **universal solvent-** most substances will dissolve in it

WHY?

- **Polar-** have two areas that have opposite charges



negative near the oxygen
b/c of unshared electrons

positive near hydrogens
fully shared electrons

SOLUTIONS

Solubility: ability of a solute to dissolve in a solvent at a certain temperature
-Looks like a single substance; particles spread out evenly until the point of saturation

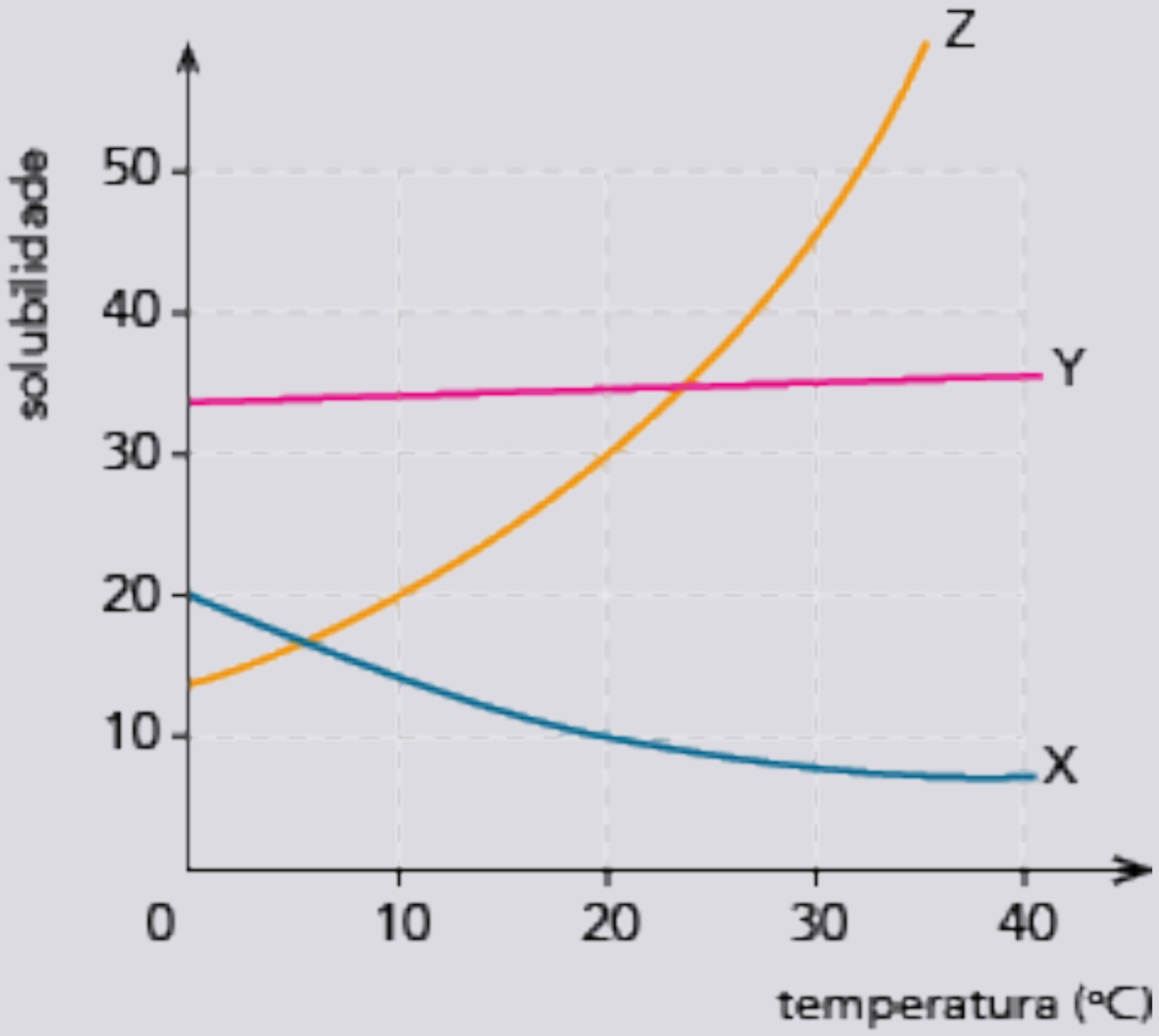
- **Concentration**: amount of solute dissolved in a solvent
    - Dilute: less solute
    - Concentrated: lots of solute
- **Saturation:** no more solute can be dissolved in the solvent

Dissolution

Atention :
Never say Melt for dissolve

When it comes to solutions, the dispersed is called solute and the dispersant, solvent.
The act of mixing two or more substances and obtaining a solution is called dissolution, therefore, to dissolve is to form a solution.
The dissolution of a certain amount of solute depends on the amount of solvent and the temperature of the system. Solubility is defined as the maximum amount of solute dissolved in a standard amount of solvent at a given temperature. Solubility can be represented by solubility curves.

Solubility x Temperature



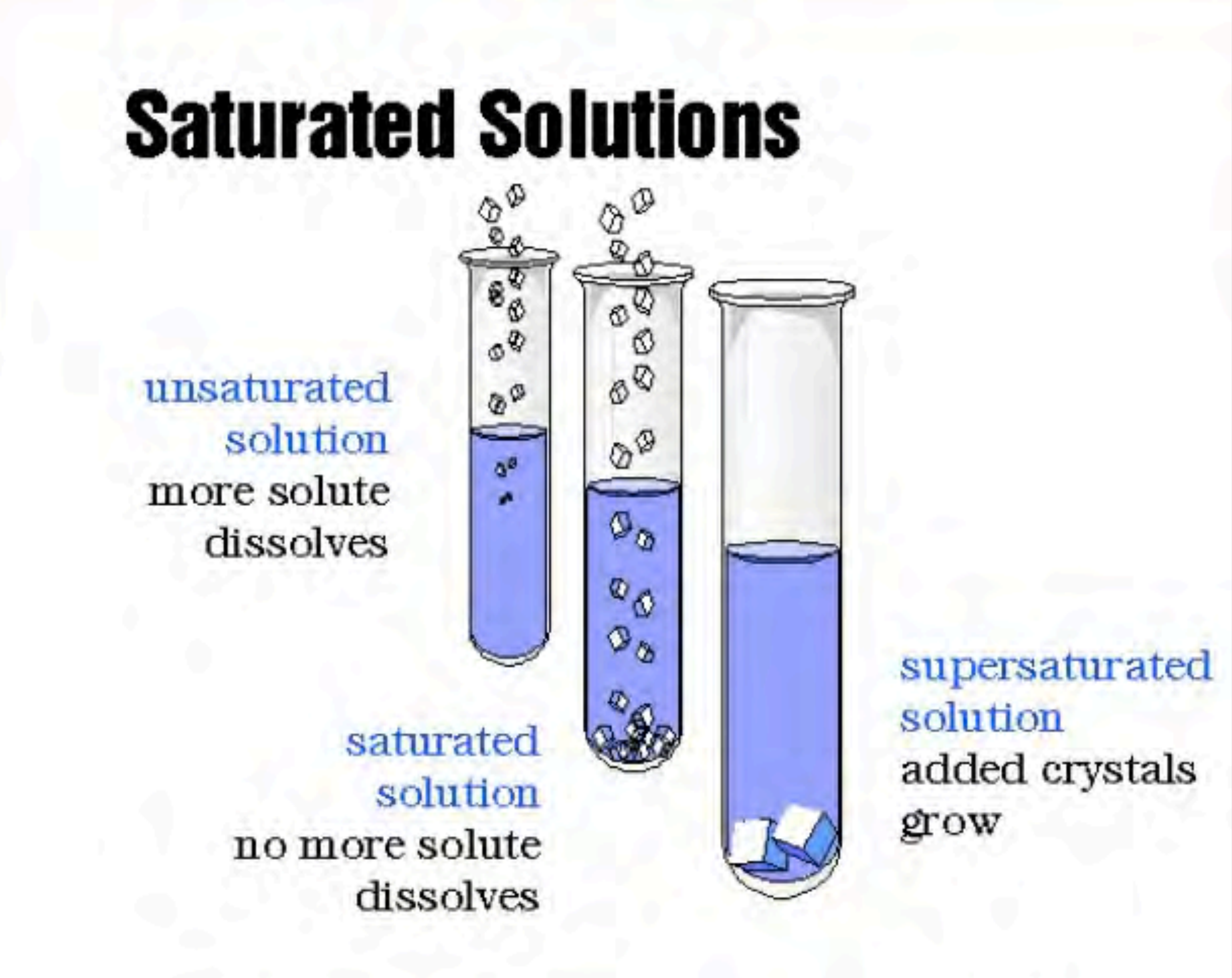
Analyzing the graph for the three substances represented by X, Y and Z:

Substance Y: it is observed that the line is practically parallel to the temperature axis. Therefore, change in temperature has little influence on solubility.

Substance Z: the curve is ascending, which means that the higher the temperature, the greater the solubility. Therefore, the dissolution of Z is endothermic. Adding Z to water, the system cools down.

Substance X the curve is downward, which means that the higher the temperature, the lower the solubility. Therefore, the dissolution of X is exothermic. By adding X in water, the system heats up.

Note: Considering water as a solvent, the vast majority of solids present endothermic dissolution. For all gases, dissolution is exothermic.



The process of dissolving solids into liquids takes place in two stages. At first, the crystal is shattered. This step is endothermic. The second step is the involvement of the solute particles by the solvent particles – this phenomenon is known as solvation.
Solvation occurs with the release of energy, because, as discussed above, when it occurs, the solvent-solute electrical attraction is greater than the solute-solute attraction. Dissolution, as a global process, will be endothermic if the crystal's dismantling energy is greater than the solvation energy. Otherwise, dissolution is exothermic.
At a given temperature, the solvent has a limit to solvate the solute particles. When this limit is reached, the solution obtained is said to be saturated. If it is not reached, the solution formed is unsaturated. And if the limit is exceeded, a solid residue is formed, which corresponds to the excess that was not solvated.
It is possible through a maneuver to exceed the limit at that temperature. The excess should be dissolved at a higher temperature and then slowly cool the solution to the starting temperature. The resulting solution is said to be supersaturated and is extremely unstable.

Concentration of the Solutions

The Most Used
mass - mass or volume -volume %

Relationships between the amounts of solute, solvent and solution

Generically called solution concentration, they can be expressed in different ways according to the chosen quantity, informing about the composition of each solution.

Mass-volume concentration g/L
the composition of the solution is expressed as the mass of the solute in relation to the volume of the solution.

Quantity of matter-volume Mol / L
in this case, the composition is given in mol per liter (mol/L).

Mass - Mass Concentration %
it is the ratio between the mass of the solid solute and the mass of the solution.

Volume - volume concentration % (degres alchool)
it is the ratio between the volume of the liquid solute and the volume of the solution

To indicate extremely small concentrations, it is customary to use the unit parts per million - ppm - it is the part of solute in a universe of 10.6 of solution and parts per billion - ppb - in this case, the total is 10.9

The composition of hydrogen peroxide is given in volumes – 10 volumes, 20 volumes, for example. The meaning of volume is the number of liters of O2 released per liter of solution, under normal conditions.

Density

Density, mass of a unit volume of a material substance. The formula for density is **d = M/V**, where d is density, M is mass, and V is volume. Density is commonly expressed in units of grams per cubic centimetre. ... Density can also be expressed as kilograms per cubic metre.
The density of the water is for about 1g/ml or 1kg/L.

Dilution

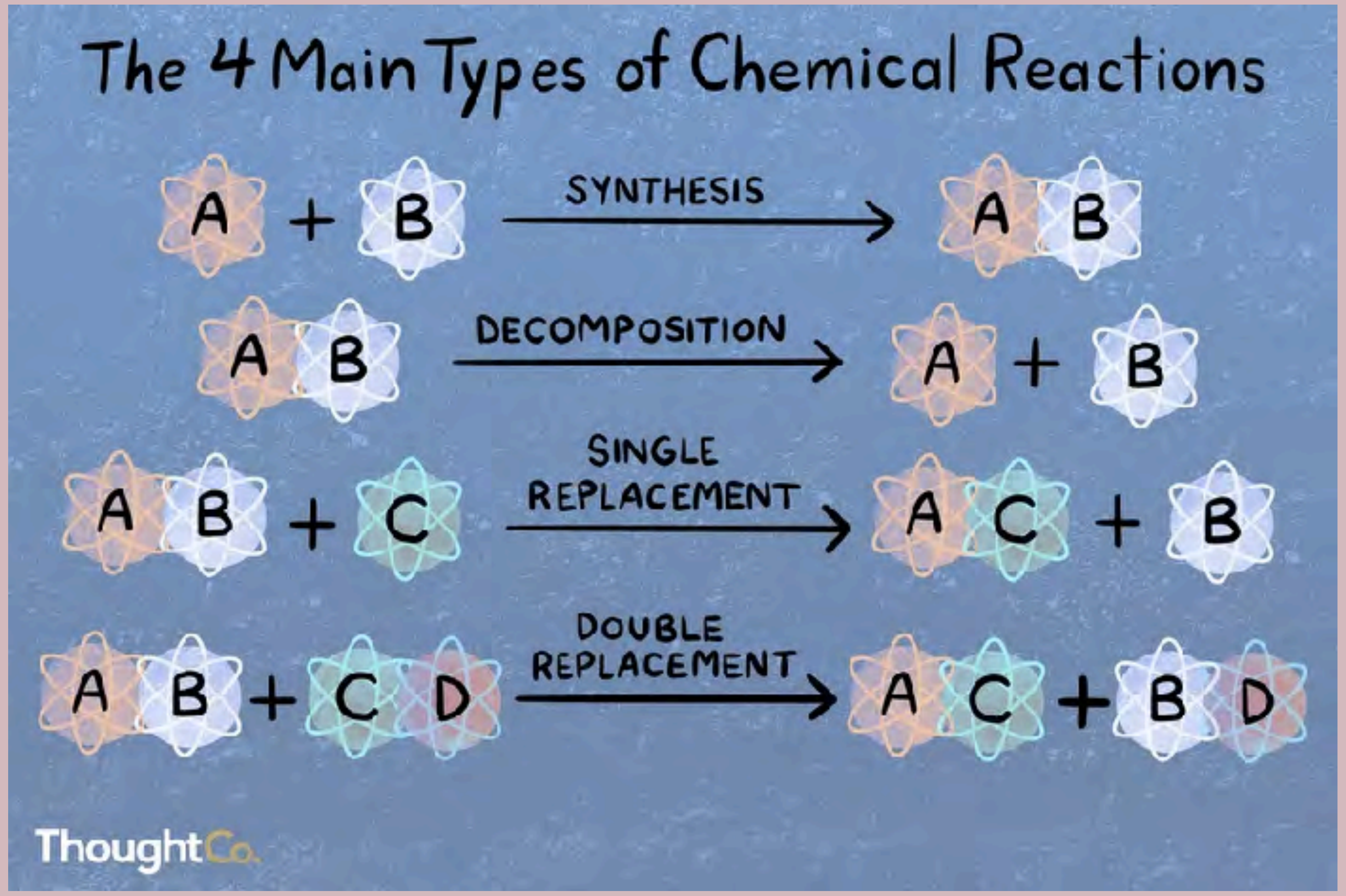
Changing the concentration of solutions by adding solvent

ex. dilution 1 : 10
10 ml of a solution 50 % + 90 ml solvent = final concentration of 5 %

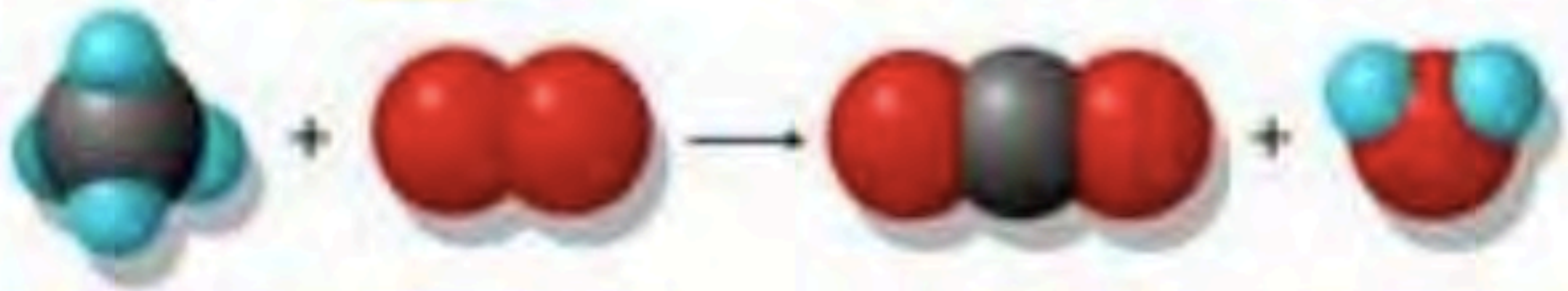
We can change the concentration of a solution by adding or removing solvent and adding solute. As it is a solution, it is impossible to remove solute.
The most used procedure in laboratories is to add solvent – the dilution.
This is because from concentrated solutions, usually stored in warehouses, it is possible to prepare solutions of varying concentrations.
The act of diluting does not change the amount of solvent, therefore, the solute-solvent ratio decreases. The concentration of the solution decreases in the same proportion as the volume of the solution increases; if the volume doubles, the concentration drops by half.
For calculation purposes, the expression Ci is used. Vi = Cf. Vf, where the index “i” indicates initial concentration and volume and the index “f” indicates the final concentration and volume.

Chemical Reactions

Chemical Reaction are processes in which one or more substances, the reactants, are converted to one or more different substances, the products. Substances are either chemical elements or compounds. A chemical reaction rearranges the constituent atoms of the reactants to create different substances as products.



$CH_4 + 2\,O_2 \longrightarrow CO_2 + 2\,H_2O$



REACTANTS $\longrightarrow$ **PRODUCTS**

Law of Conservation of matter: matter is neither created or destroyed (Mass stays the same)

CHEMICAL EQUATIONS

gas *gas* *water*

$$2H_2 + O_2 \longrightarrow 2H_2O$$

reactant → **product**

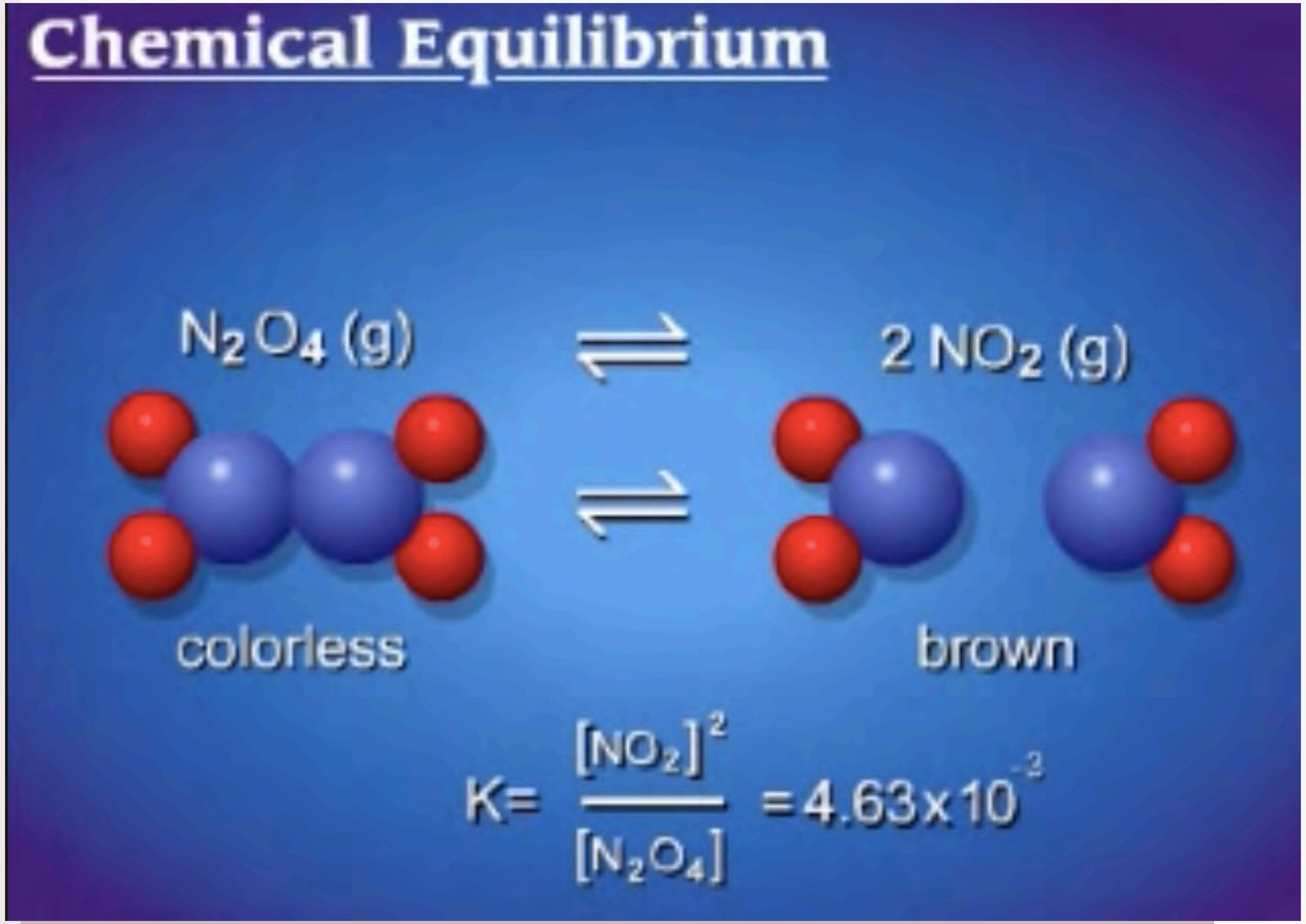
coefficient (how many molecules)

subscript (how many atoms)

Chemical Equilibrium

Chemical equilibrium, condition in the course of a reversible chemical reaction in which **no net change in the amounts of reactants and products occurs**. ... At equilibrium, the two opposing reactions go on at equal rates, or velocities, and hence there is no net change in the amounts of substances involved.

Ex.: Dinitrogen Tetraoxide decompoundes in Nitrogen Dioxide

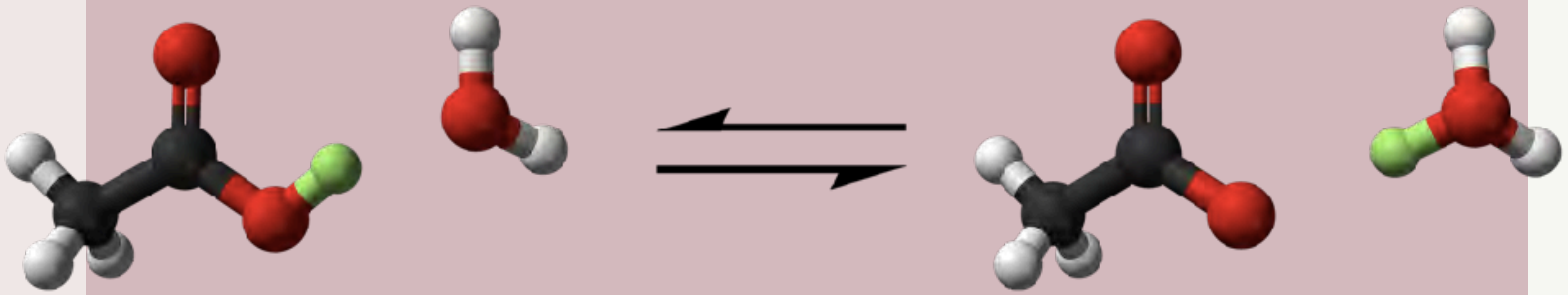


https://www.accessscience.com/content/chemical-equilibrium/127300

… but what finally pH is???

In chemistry, **pH (**historically denoting "potential of hydrogen" or "power of hydrogen")[1] is a scale used to specify the acidity or basicity of an aqueous solution. Acidic solutions (solutions with higher concentrations of H^+ ions) are measured to have lower pH values than basic or alkaline solutions.

At 25 °C, solutions with a pH less than 7 are acidic, and solutions with a pH greater than 7 are basic. Solutions with a pH of 7 at this temperature are neutral (e.g. pure water). The neutral value of the pH depends on the temperature – being lower than 7 if the temperature increases. The pH value can be less than 0 for very strong acids, or greater than 14 for very strong bases.[3]



Diagrammatic representation of the dissociation of acetic acid in aqueous solution to acetate and hydronium ions.

Practical Tips

Effect of pH in Natural Dye

When we work with dyes, specially natural dyes, it is very important to control the pH, that is the measure of the level of acidity or basicity, of the solution or the tintorium bath. This is because the components may change their colors with the change of the pH, and also because there is a ideal pH for each process.

To measure the pH you can use the indicators strips http://acidsandbaseskate.weebly.com/indicators.html and it is better to work in the neutral pH or for about Ph 7, most of the times.

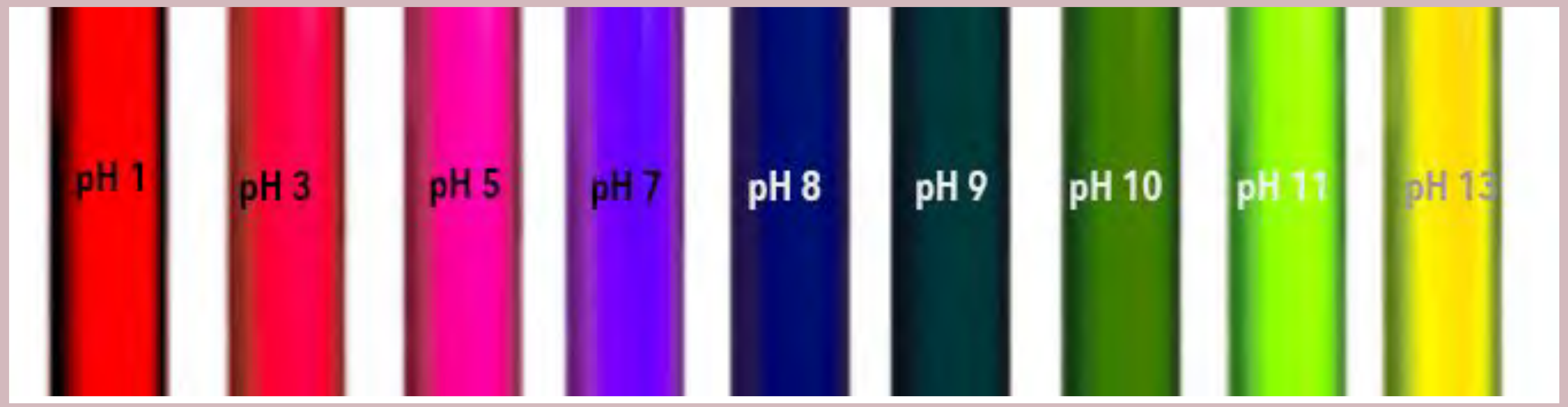
If you don't have the possibility to bye immediatly the Indicator strips, you can use some Natural indicators, for at least to know if your solution is Acid, Neutral or Basic, sometimes is the only thing you need to know.

-

Using Purple Cabbage as Indicator

Take one leaf of a Purple Cabbage beat in the blender and strain . This extract will be our indicator. If you don't use imediatly, hold in refrigerator and dark. If you want to see all the scale of colors you can divide the extract in 12 tubes and put in them these components in this order:

lemon, vinegar, detergent, milk, sugar, ammonia salt, soap powder,bleach, caustic soda and obtain the result below, that goes from the most acid (Ph 1 to the most alkaline Ph 13):



pH effect in natural Dying Purple Cabbage

For me it was important only to detect if the solution is Acid , Neutral or Alkaline, because I would use it to dye and not really to know the Ph, so to detect how the pH influence the resulting color of dyeing I used some of the components first to test, and finally only two of them to change the pH of the dyeing bath.

I followed the steps below:

Use 250 g of chopped Purple Cabbage in 1250ml of water, boil this mixture for 40min. After I strainned to obtain the Purple extract of the Cabbage that was purple because the Ph was neutral, or for about seven.

First I've tested in a smal portion of the extract, to check the changes of the color with the pH, with the addition of the components: Lemon , detergent, sodium bicarbonate, sugar and vinager. Then I've choosed in the resulting colors those components I would work with: lemon to acidify the extract and sodium bicarbonate to alkalize it, even because they are natural agents and can be easily find in a kitchen.

To dye I divided the extract in three portions of 300 ml; and add 1/2 lemon to the first, nothing to the second and 1 spoon tea of sodium bicarbonate to the third one. Then I introduce gently the samples of fabric and fibers, and let it boil for 40min, stiring gently sometimes.

The results can be seen in the image below: First, on the left, the test with the addition of the agents to change the Ph, after the Purple Cabbage.

Than the three extracts and the three baths in order: on the left the red one, with lemon, or the acid one, with pH less than 7; in the middle the purple one, in natural or Neutral pH, without adding anything, pH for about ; and in the right the green one, with sodium bicarbonate, the alcalyne one, with pH more than 7.

In the extreme right of the image we have the samples dyed in these conditions: The wool in Yarn and the fabric samples wool, cotton and linen from the top to the botton.

.


natural
Lemon
detergent
sodium bicarbonate
sugar
vinager
253

CHANGES

Physical change: the matter changes shape; atoms stay the same substance

- Liquid water freezes
- Paper is torn

Chemical change: the atoms in the matter rearrange; become a new substance

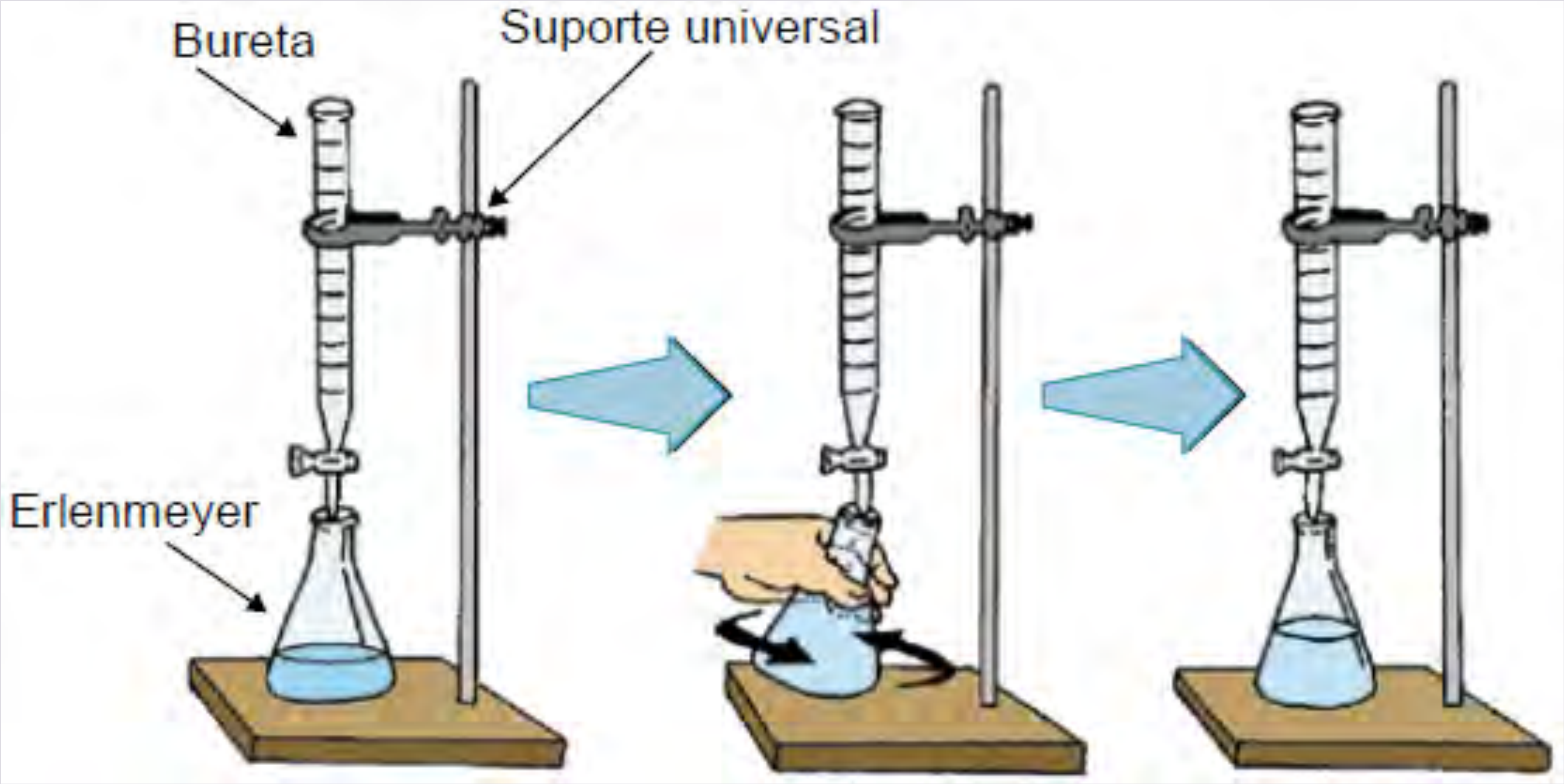
- Wood burns $\longrightarrow$ char ash & smoke

$$6C_{10}H_{15}0_7 \ + \ \text{HEAT} \longrightarrow C_{50}H_{10}0 \ + \ 10\,CH_2 0$$

- Iron nail oxidizes $\longrightarrow$ rust

$$4Fe \ + \ 3\,0_2 \longrightarrow 2Fe_2O_3$$

Titration of FeOH2



Titration is the method to determine the concentration of a component in a mixture, by a chemical reaction.

In the case of Iron it will be a reduction oxide reaction

Promptly titrate FeOH2 (iron Oxide 2) in acid medium , with a standard solution of KMn04 (Potassium permanganate) to a purple end point.

The permanganate solution is purple and when it falls into the iron solution it reacts and becomes colorless, when the iron is finished it does not change color anymore making the solution purple

- Always introduce Acid or Base in Water , never the other way around

- Always use the glass stick to stir the solutions and to pour from one bottle to another.

- Never insert the indicator paper into your solutions , but use the glass stick to pour a little amount of the mixture over the paper.

- always rest the stick on a stand and never on the table

Stablishing the Solutes Concentration for Recipes

Bioplastic Recipe

- Gelatine powder 48 g
- Cold Water 240 ml
- Glycerol 12g
- rule of three

or 48 —- 240
x —— 100

$$x = \frac{48 \times 100}{240}$$

$$x = 20$$

Gelatin 20 g

Glycerol 5 ml

Distilled Water 100 ml

Resuming the solution should have the following concentrations

Gelatin 20%

Glycerol 5%

for the basic recipe of Bio-Plastic

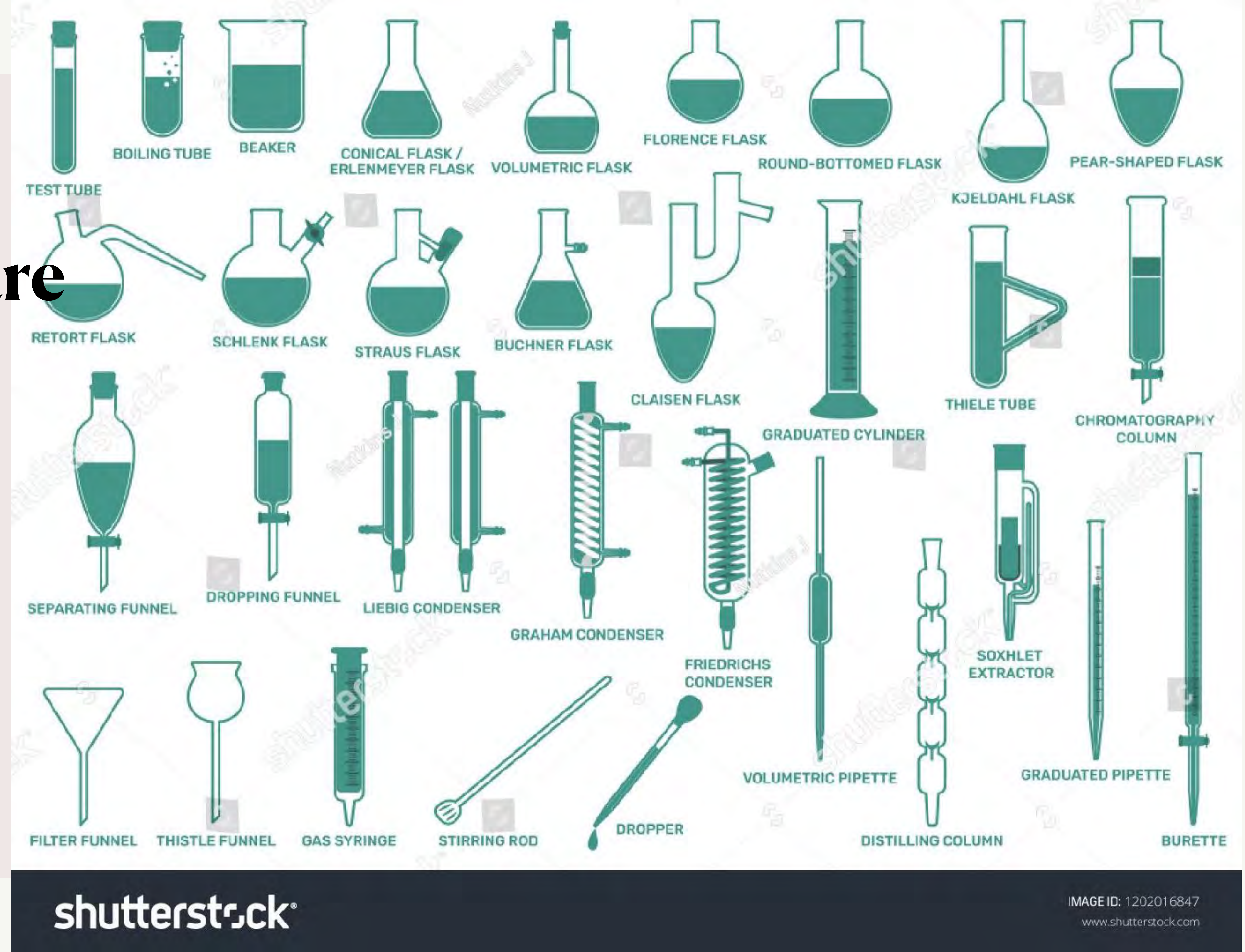
or using the qsp (quantidade suficiente para) in english uses qs (quantum satis / quantum sufficit)

Gelatin 20g

Glycerol 5 ml

Distilled water qs 100ml

Lab Glassware




250
ml
150
50

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