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UNIT 2.

MATTER. PROPERTIES OF MATTER

1. MATTER.PROPERTIES OF MATTER. DENSITY

Matter is defined as anything that has mass and occupies a volume. A ***material system*** is a portion of matter used for being the subject of study.

Mass and volume are ***general properties of matter*** because they do not depend on the substance which compounds a material system.

However, other properties define which substance the material system is made of. They are called ***specific properties of matter.***

Density is one specific property of matter, which indicates the mass of substance contained in a given unit of volume. The international system unit of density is kg/m^3 which are the kilograms of substance contained in a cubic meter of volume.

$$Density = \frac{mass}{Volume} \longrightarrow D = \frac{m}{V}$$

Notice that a coherence of units is needed to solve the equation.

But, **how is this equation used?**

Look at these examples:

1. What is the density of a piece of wood which has a mass of 25 g and occupies a volume of 35 cm^3? Would the piece of wood float in water?

DATA	Solving method
m = 25g V = 35cm^3 D = ?	$D = \frac{m}{V}$ $D = \frac{25g}{35cm^3} = 0{,}71\,g/cm^3$

The density of the piece of wood is smaller than the density of water (which is 1g/cm^3). Therefore, the piece of wood would float in water.

2. What is the mass of oil contained in a bottle of ¾ L? The density of oil is 920 kg/m^3

DATA	Solving method
m = ? V = 3/4L D = 920 kg/m^3	There is no equivalence among units. We must use conversion factors $1m^3 = 10^3dm^3 = 10^3L$

$$\frac{3}{4}L \cdot \frac{1m^3}{10^3L} = 7{,}5 \cdot 10^{-4}m^3$$

$$D = \frac{m}{V}$$

$$920\,kg/m^3 = \frac{m}{7{,}5.10^{-4}m^3} \rightarrow m = 920\,kg/m^3 \cdot 7{,}5.10^{-4}m^3 = 0{,}69kg = 690g$$

3. Which volume occupies a piece of aluminium with a mass of 3,5 kg? The density of aluminium is 2,7 g/cm^3

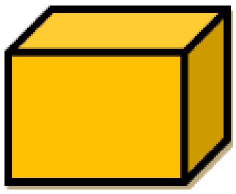
DATA	Solving method
m = 3,5 kg V = ? D = 2,7 g/cm^3	There is no equivalence among units. We must use conversion factors $1kg = 10^3g$

$$3{,}5\,kg \cdot \frac{10^3 g}{1\,kg} = 3500\,g$$

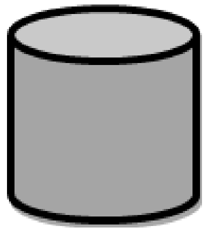
$$D = \frac{m}{V}$$

$$2{,}7\,g/cm^3 = \frac{3500g}{V} \rightarrow V = \frac{3500g}{2{,}7\,g/cm^3} = 1296cm^3$$

The most complicated problems include the calculation of the piece´s volume. The most usual volumes are:



$$V = l_1 \cdot l_2 \cdot l_3$$



$$V = \pi \cdot r^2 \cdot h$$

$$V = \frac{4}{3} \pi \cdot r^3$$

TABLE OF DENSITIES FOR SOME COMMON MATERIALS

COMMON MATERIALS		COMMON METALS	
SUBSTANCE	**DENSITY (g/cm^3)**	**SUBSTANCE**	**DENSITY (g/cm^3)**
Water	1,00	Aluminum	2,70
Glass	2,60	Mercury	13,60
Granite	2,650	Brass	8,40
Bone	1,85	Nickel	8,80
Human Body	0,995	Chromium	7,10
Butter	0,94	Platinum	21,50
Ice	0,917	Cooper	8,63
Carbon	2,60	Silver	10,40
Salt	2,200	Gold	19,30
Sand	2,800	Tin	7,30
Cork	0,25	Iron	7,80
Sulphuric Acid	1,840	Lead	11,30
Gasoline	0,72	Zinc	6,90

Table 2.A

Practice the density concept solving the following problems:

1. Taking in mind Table 2.A, express the densities of gasoline, sand and lead in the International System unit.

2. Calculate the density of an object whose mass is 10,5 g and that occupies a volume of 5 cm^3. Express it in g/cm^3 and kg/m^3

3. The density of a substance is 1200 kg/m^3 and its mass is 24 kg ¿Can you know its volume? Express it in cm^3.

4. The density of a liquid is 800 kg/m^3. How many mass is contained in 0,5 m^3 ? Express it in g.

5. 3 cubic centimetres of a liquid have a mass of 5 grams. Determine its density in kg/m^3

6. An object made of copper occupies a volume of 4dm^3. Calculate its mass in grams. (take the density of the table 2.A)

7. Three litres of a liquid have a mass of 2 kg. Calculate its density in g/cm^3.

8. A cube made of lead has an edge of 7 cm. Calculate its mass in kg. (take the density from table 2.A)

9. A cylinder with a radius of 5 cm and a height of 7 cm has a mass of 450 g. Calculate the density of the substance it is made of. Does it float on water?

10. A sphere made of granite, has a radius of 8 m. Calculate its mass in kg. (take the density from table 2.A)

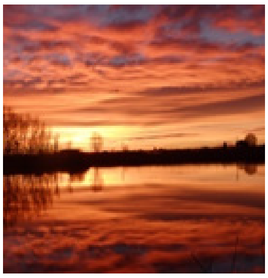
11. A square prism has edges of 5cm, 10 cm and 15 cm. It is made of a wooden whose density is 850kg/m^3 . Calculate its mass.

2. STATES OF AGGREGATION OF MATTER: SOLID, LIQUID AND GAS.

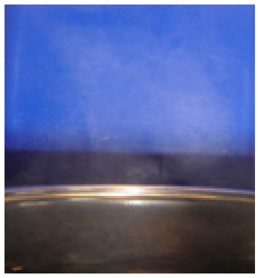
Matter can be in three different states of aggregation: solid, liquid and gas.

Solid

Liquid



Gas

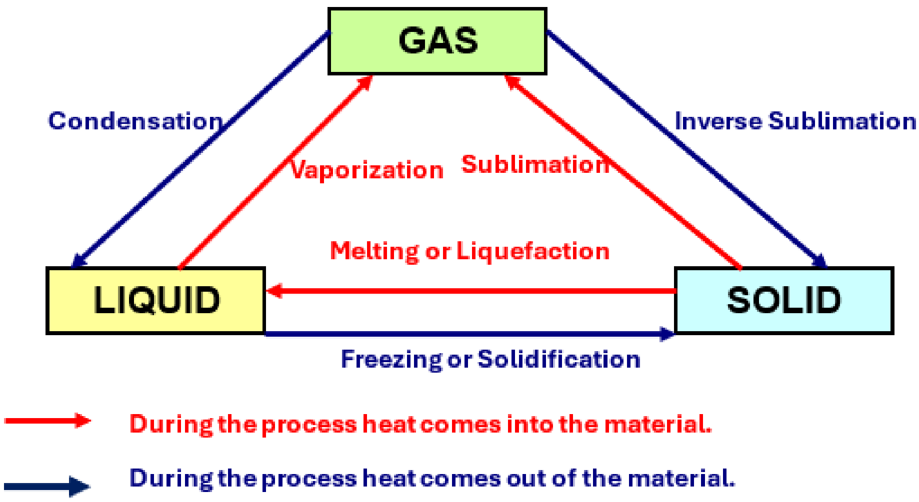


Properties of solids, liquids and gases are summarized in the following table:

PROPERTY	SOLID	LIQUID	GAS
SHAPE	Fixed	Same as container (not defined)	Same as container (not defined)
VOLUME	Defined	Defined	Fills entire container (not defined)
ABILITY TO FLOW	No	Yes	Yes
CAN BE COMPRESSED?	Very slightly	Very slightly	Yes
DENSITY	High	High	Low

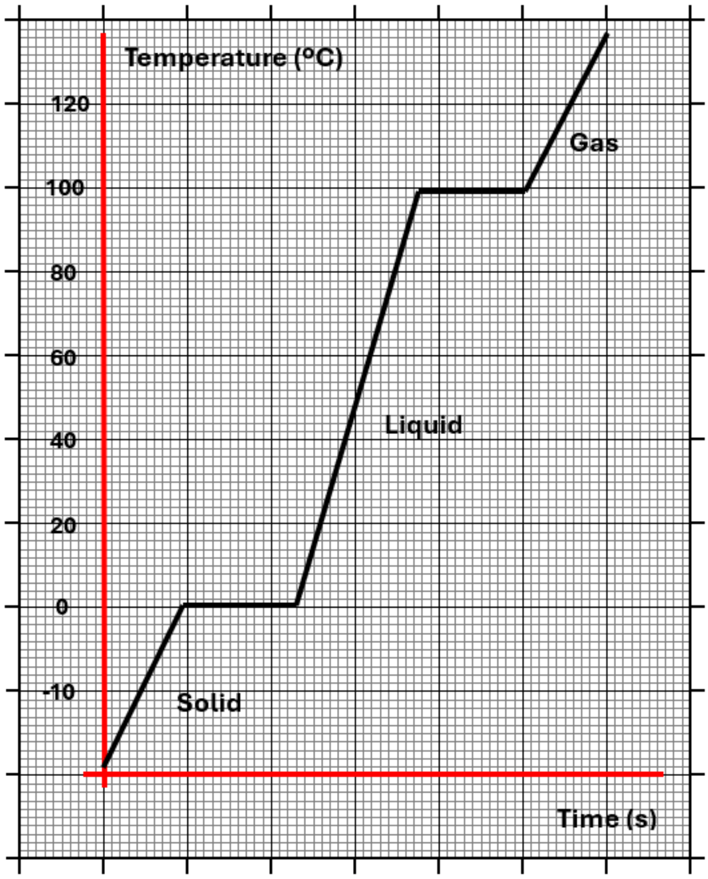
Table 2.B

Material systems can exist in a solid, liquid, and gaseous state of aggregation and can change from one to another when there are changes in conditions such as temperature and pressure. The possible changes of state are represented in the following diagram:



Vaporization includes two different processes:

- **Evaporation:** It is a slow process which takes place at any temperature, only on the surface of liquids. For example, leave a dish with water on a table. After a few hours there is no water in the dish because it has evaporated. If you do the same experiment in a glass with a smaller surface it will take more time for the water to evaporate.
- **Boiling:** It is a fast process which involves all the volume of the liquid and only at the boiling temperature, specific for each substance. For example water boils approximately at 100ºC.



Attention! Keep in mind that all these processes happen without any change in temperature. The temperature of the material remains constant during the change of state or phase.

Melting point of a substance is the temperature at which the substance state changes from solid to liquid.

Boiling point of a liquid is the temperature at which all the liquid volume change to gas state.

Melting point and boiling point are specific properties of matter and they depend on the pressure. For example, we always say that "water boils at a temperature of 100ºC". Well, that is not really true; water boils at 100ºC when the atmospheric pressure is 1 atm. If the atmospheric pressure is higher, water boils at a higher temperature, and if the pressure is lower, water boils at a lower temperature. It is the same with the melting point.

Look at the next graphic that shows the change of state of water as it is heated.

We start with ice at -20ºC (water in solid state). As we heat it, the temperature increases until it reaches 0ºC. Then a change of state takes place, from solid to liquid. As the ice is becoming liquid water, the temperature is constant (melting point = 0ºC). When all the ice has become liquid the temperature rises again until it reaches 100ºC. Again, a change of state is taking place (boiling point = 100ºC), so the temperature stays constant until all the water has become steam. When that happens, temperature increases again.

EXERCISES

12. Explain why clothes dry faster when they are hanged on the rope than when they are left in the bucket.

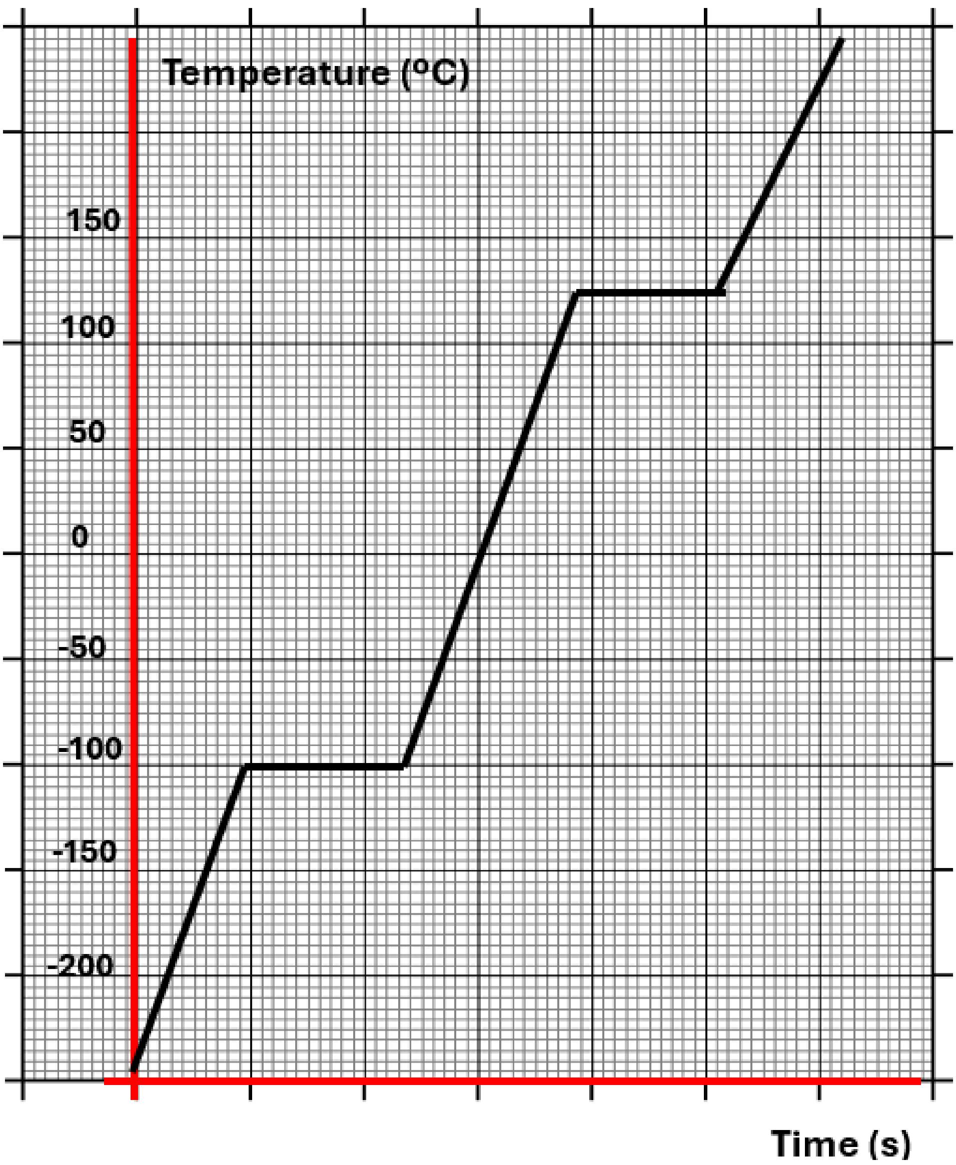
13. When you take a hot shower the bathroom usually gets full of steam. But why does the mirror steam up?

14. In winter, many mornings the windscreens of some cars are frozen. Explain this phenomenon.

15. Some fridges have ice on the back of them. Where does this ice come from?

16. We have said the boiling point depends on the pressure. That is the principle working behind the pressure cooker. Try to explain in your own words why the pressure cooker cooks faster than normal casseroles.

17. The next graphic shows the change of states with the time of alcohol. Mark the three states of matter on the graphic and write the melting and the boiling point of that substance.

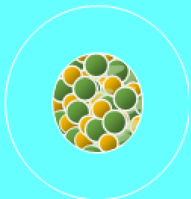
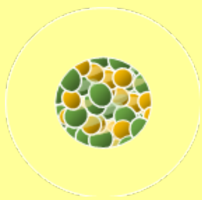
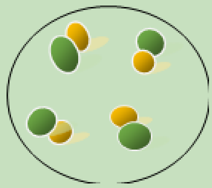


3. KINETIC MOLECULAR THEORY

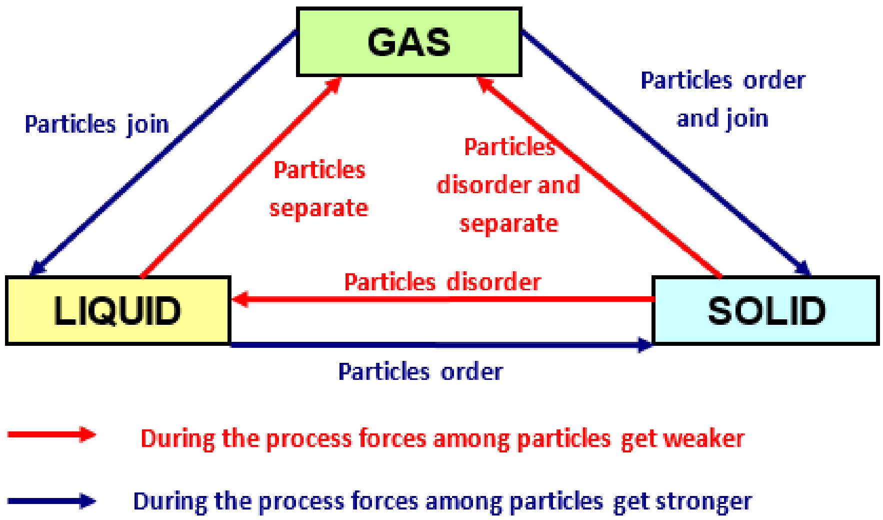
The Kinetic molecular theory explains the differences among the three states of aggregation and the processes involved in the changes of state. It can be summarized in the following points:

- All matter is made of tiny particles in constant motion
- Their motion increases as they gain energy. Higher temperature implies higher motion.
- These particles are joined by cohesion forces.
- Pressure in gases and liquids is interpreted by this theory as the frequency of collisions among particles and against the walls of the container.

Based in the points before, the three states of the matter and their properties are explained by the Kinetic Molecular Theory as the following table summarizes:

	SOLID	LIQUID	GAS
IMAGE OF PARTICLES			
PARTICLES	Joined	Joined	Separated
MOVEMENT	Vibration around their fixed position	Displacement	Free displacement
FORCES AMONG PARTICLES	Strong	Medium	Extremely weak
SHAPE	Particles strongly joined by cohesion forces make solids have a fixed shape	Displacing particles spread all over the total space in the container	Free particles move an expand all over the space
VOLUME	Joined particles make solids have a defined volume	Joined particles make liquids have a defined volume	Particles with free movement tend to fill entire container. Gases don´t have a defined volume
ABILITY TO FLOW	Particles are in their fixed position	Particles displacing give liquids the ability to flow	Particles displacing freely give gases the ability to flow
CAN BE COMPRESSED?	Very slightly because particles are joined	Very slightly because particles are joined	Yes. Particles are separated and can be joined.
DENSITY	Joined particles is traduced as a high value of mass per unit of volume = high density	Joined particles is tra-duced as a high value of mass per unit of volume = high density	Separated particles is traduced as a low mass per unit of volume = low density

The following diagram explains how forces among particles change and, consequently, what happens to particles when a change of state takes place:



Practice the density concept solving the following problems:

18. Indicate the differences among the properties of solids and liquids, using table 2.B information

19. Summarize the differences among the properties of liquids and gases, using table 2.B information

20. Complete the following sentences:

a. Melting temperature of Iron is 1539ºC. The state of aggregation of iron at 25ºC is: .... while the state of aggregation at 2000ºC is ....

b. Water has a melting point of 0ºC and a boiling point of 100ºC in normal pressure conditions. The state of aggregation of water at 200ºC is ...., at -23ºC is .... and at 25ºC is ....

c. The boiling point of nitrogen is – 196ºC . Its state of aggregation is liquid at .... At 20ºC the state of nitrogen is ....

d. Salt has a melting point of 800ºC. At 200ºC the state of aggregation of salt is .... and at 1000ºC salt is in .... state.

e. Bromine has a melting point of -7,2ºC. At 30ºC bromide is in .... state.

f. The boiling point of a substance is 78,5º C and the melting point is 2ºC. At 100ºC the substance is in .... state. At 50ºC it is in .... state and at 0ºC it is in .... state.

g. The boiling point of a substance is 200º C and the melting point is 23ºC. At 0ºC the substance is in .... state. At 100ºC it is in .... state and at 300ºC it is in .... state.

21. Match the states of the matter with the suitable statements:

	Fixed volume	Separated particles
Solid	Determined shape	Particles vibrating around a fixed position
	Can be compressible	Joined particles
	Variable shape	Particles ordered in fix positions
Liquid	High density	Joined but displacing particles
	Low density	Strong attraction forces
	Can flow	Medium attraction forces
Gas	Impossible flowing	Extremely low forces

22. Complete the following sentences, taking in mind exercise 4.

a. Particles in solids ....due to attraction forces are .... As a consequence properties of solids are: ....shape .... volume and .... density.

b. Particles in liquids ....due to attraction forces are .... As a consequence properties of liquids are: .... shape .... volume and .... density

c. Particles in gases ....due to attraction forces are .... As a consequence properties of gases are: .... shape .... volume and .... density

d. .... and .... can flow because their particles ....

23. Add the correct Word:

a. A substance change from liquid to solid state. That change of aggregation is called..

b. A substance change from solid to liquid state. That change of aggregation is called..

c. A substance change from liquid to gas state. That change of aggregation is called..

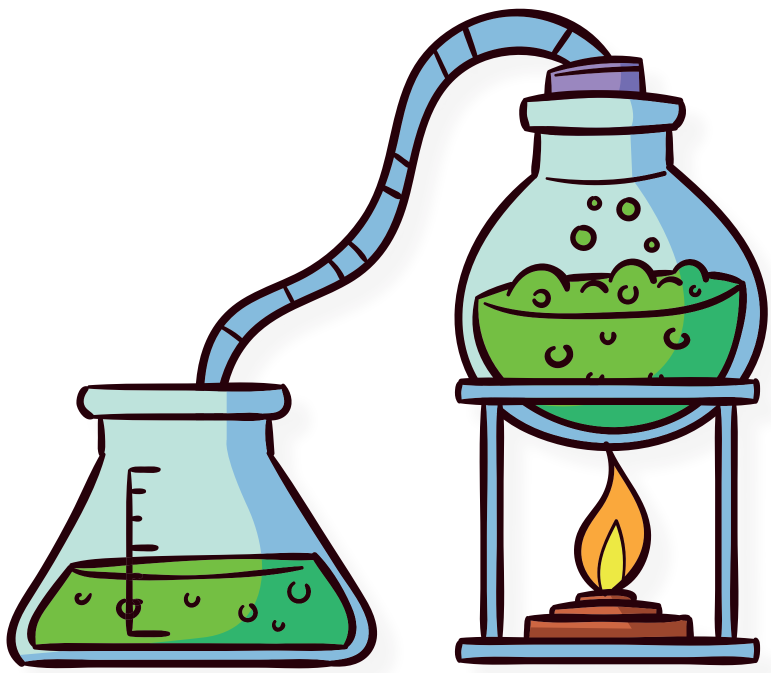
d. A substance change from gas to liquid state. That change of aggregation is called..

e. A substance change from gas to solid state. That change of aggregation is called..

f. A substance change from solid to gas state. That change of aggregation is called..

24. Imagine you leave a glass on a table with four ice cubes inside. Describe what would happen over the time. If you put a thermometer inside, can you explain which temperature it would measure during the process?

25. You put a little rock inside a graduated cylinder; does it take the shape of the cylinder? Why? If you put 10 mL of alcohol inside the graduated cylinder; does it take the cylinder shape? Can you explain it?



4. CONDITIONS OF A MATERIAL SYSTEM. TEMPERATURE AND PRESSURE

Pressure and temperature are properties of matter called conditions. Kinetic-Molecular Theory interprets them as:

- Temperature shows the rate of motion of tiny particles which compounds an object or a substance. Higher temperature is interpreted as higher rate of motion of particles.
- Pressure shows the frequency of collisions among particles and against the walls of the container where the substance is. Higher pressure is interpreted as higher frequency of collisions.

The international System unit of Temperature is Kelvin (K) but usually other units are used, such as Celsius degree (ºC) and Fahrenheit degree (ºF). The following diagram helps you to understand their proportion:

KELVIN SCALE	CELSIUS SCALE
373K 100 273K	100ºC 100ºC 0ºC
ICE MELTING POINT: 273 K	ICE MELTING POINT: 0ºC
WATER BOILING POINT: 373 k	WATER BOILING POINT: 100ºC

Based in that proportion the equation used to make the corresponding change of units is:

$$^{\circ}C = K - 273$$

The International System unit of pressure is Pascal (Pa) but other unit are used such as atmosphere (atm), millimetre mercury (mmHg) and bar. The following equivalences are used to make conversions:

$$1\ atm = 101300Pa = 760mmHg$$

$$1bar = 10^{5}Pa$$

Look at the following example:

1. **A sample of gas in under the following conditions: 45ºC and 2,5 atm. Express them in the International system unit**

Pressure	Temepereture
$1\ atm = 101300Pa$	$\frac{ºC}{100} = \frac{K-273}{100}$
$2{,}5atm \cdot \frac{101300Pa}{1atm} = 253250\ Pa$	$ºC = K - 273$
	$45ºC = K - 273$
	$45ºC + 273 = K$
	$T(K) = 318\ K$

Practice the density concept solving the following problems:

26. Express in Celsius degrees:

a. 47 K

b. 312 K

c. 82 K

d. 500 K

27. Convert to the International System Unit:

a. 120ºC

b. 300ºC

c. -12ºC

d. -54ºC

28. Make the asked conversions using conversion factors.

a. 3 atm to Pa

b. 1,2 bar to Pa

c. 1,7 atm to mmHg

d. 860 mmHg to atm

5. GAS LAWS

Boyle's Law: It relates pressure and volume of ideal gases when temperature remains constant.

Pressure and volume are inversely proportional to each other. This means that as the pressure decreases, the volume increases, and as the pressure increases, the volume decreases. One way to think of this is if you push on a gas by decreasing its volume, it pushes back by increasing its pressure.

This can be explained by the Kinetic theory. Think of a recipient full of a gas with a piston as you can see in the picture below:

If the piston is moved down (making the volume smaller) the particles of the gas will be closer and therefore they will collide more frequently against the wall of the recipient and against themselves, making the pressure higher.

If the piston is moved up (making the volume higher) the particles of the gas will be further and therefore they will collide less frequently against the wall of the recipient and against themselves, making the pressure lower.

We can say then that pressure and volume are inversely proportional.

Mathematically the law is expressed:

$$P \cdot V = k$$

That means that the product of pressure and volume is always constant.

But for us is more useful to express it as:

$$P_1 \cdot V_1 = P_2 \cdot V_2$$

That means that the product of initial pressure and volume is equal to the product of final pressure and volume.

Gay-Lussac's Laws:

Temperature and pressure of ideal gases are directly proportional to each other when volume remains constant. This means that as the temperature decreases, the pressure also decreases, and as the temperature increases, the pressure increases. One way to think of this is if you increase the speed of the molecules –by increasing their temperature- the frequency of collisions against the container increases and this increases the pressure. Mathematically the law is expressed:

That means that the product of initial pressure and volume is equal to the product of final pressure and volume.

$$\frac{P}{T} = k \quad \text{or} \quad \frac{P_1}{T_1} = \frac{P_2}{T_2}$$

Temperature and volume of ideal gases are directly proportional to each other when pressure remains constant. This means that as temperature increases, volume increases and as temperature decreases, volume also decreases. If the speed of particles increases, it is necessary an increase of the distances covered so the frequency of collisions remains constant.

Think for example of a balloon (which is elastic) full of a gas. If we put it close to a heater the temperature inside the balloon will increase making the particles move faster inside the balloon. As the pressure is constant, it is necessary that the balloon's volume increases so the number of collisions against the surface of the balloon is the same as it was before being heated.

$$\frac{V}{T} = k \quad \text{or} \quad \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Combined gas Law: It relates temperature, pressure and volume when none of them remain constant. Mathematically it consists in a combination of the other previous laws:

$$\frac{P \cdot V}{T} = k \quad \text{or} \quad \frac{P_1 \cdot V_1}{T_1} = \frac{P_2 \cdot V_2}{T_2}$$

Attention! Temperature is always used in the International System unit (K).

But, how are these laws used?

Look at the example:

If the volume of a gas remains unchanged, the container under a pressure of 1 atm is heated from 25ºC to 100ºC. What is the gas pressure after finishing the experiment?

Data

T_1= 25ºC

V_1= 2 L

T_2=100ºC

V_2=?

Solving method

Firstly you need to express temperatures in Kelvin

ºC=K-273

T_1(K)=298K

T_2(K)=373K

Then, you have to use the adequate gas law:

As volume is constant we should use the first Gay-Lussac law

$$\frac{P}{T} = k$$

Wich is the same as:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{1atm}{298K} = \frac{P}{373K}$$

$$P = \frac{1atm}{298K} . 373K = 1{,}25\ atm$$

Practice the density concept solving the following problems:

1. Initially, we have a recipient closed by a piston with a volume of 1 L that is under a pressure of 750 mmHg. If we push he piston so the final volume is 250 mL, what will the final pressure be?

2. Now we have the same recipient, closed by a piston, with a volume of 750 mL under a pressure of 1 atm. If we want it to be under a pressure of 1580 mmHg, what will the final volume be?

3. There is a balloon in the classroom, with a volume of 1,5 L and at a temperature of 25 ºC. We put it close to the heater and it reaches a temperature of 50ºC. Which will the final volume be?

4. The same balloon, with a volume of 1,5 L and at a temperature of 25ºC is now put on the fridge, and at the end of the experiment has a volume of 600 mL. Which is the temperature inside the balloon?

5. A spray deodorant has a pressure inside of 1520 mmHg at a temperature of 20ºC. If it is heated until it reaches a temperature of 100 ºC, what will be the final pressure inside the spray? We know that a spray will explode when it has a pressure inside bigger than 8 amt. Will this spray explode?

6. We have a recipient of 5 L under a pressure of 3 atm and at a temperature of 300K. If we keep constant its volume, what will be the final temperature if the final pressure is 1 atm?

7. There is a recipient of 3 dm^3 under a pressure of 1200 mmHg and at a temperature of 20º C. If the final volume is 5 L and the final pressure is 3 atm, what will be the final temperature?

6. LEARNING SITUATION: MEASURING THE DENSITY OF A SUBSTANCE.

OBJETIVES:

1. To measure mass and volume in bodies.
2. To practice with two different methods of measuring the volume of solid objects.
3. To calculate density values using mass and volume experimental measurements.
4. To prove that density is a specific property of matter.

MATERIAL: GRADUATED CYLINDER, ELECTRONIC BALANCE, CALIBER, DIFFERET PIECES MADE OF THE SAME MATERIAL.

WORK IN PAIRS OR GROUPS OF THREE:

ASK A QUESTION:

Observe around and ask for the density of a substance in objects you use. Choose different objects that you think are made of the same material. Tell your teacher what objects you are going to use.

BACKGROUND RESEARCH

Look information about how you can get the density of a body and describe the process in detail.

PLAN YOUR EXPERIMENTATION

Think about what material do you need and plan your experiment.

PERFORM YOUR EXPERIMENTATION AND ANALIZE YOUR DATA

Measure magnitudes, note down their values on a table and calculate the density of each body.

CONCLUSION

Answer the following questions:

- Are your bodies made of the same substance?
- What substance are your bodies made of?

WRITE A REPORT

Make a power point presentation about your experimentation, showing all the steps you have followed in your research.

7. LEARNING SITUATION. TICKTOCKER LABORATORY: AN EASY WAY TO OBSERVE GAS LAWS.

OBJETIVES:

1. To observe examples of gas laws and gas behaviour.
2. To explain the observations made using the Kinetic-Molecular Theory

MATERIAL: SYRINGES, BOTTLES, PLASTICINE, BALLOONS, NEWSPAPER, RULER, GLASS, etc.

WORK IN PAIRS:

Choose one of the following experiments and record a video about it. Try to explain what happens using the kinetic molecular theory and the behaviour of gasses.

EXPERIMENT 1

Place an open plastic bottle in the fridge for 2 hours.

Take the bottle out of the fridge and put a balloon on its mouth.

Observe what happens.

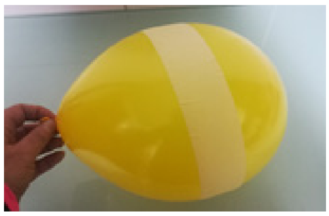
Cover the bottle with your hands to heat it quickly. You can use a heating blanket to heat the bottle.

EXPERIMENT 2

Blow up a balloon and stick an adhesive strip around it. Put it into the freezer for a while (at least, 1 hour).

Take the balloon out of the freezer. Observe what has happened.

Observe what happens when its temperature increases.



EXPERIMENT 3

Place a balloon on the mouth of a bottle.

Insert the bottle in a container with hot water. What is happening?

Afterwards, insert the bottle in the container with ice. What is happening now?

EXPERIMENT 4

Fill a balloon only a bit with air and tie it.

Place the balloon on the mouth of a plastic bottle.

Insert the bottle into a container filled with hot water. What is happening?

EXPERIMENT 5

Fill a balloon only a bit with air and close it.

Place the balloon on the mouth of a plastic bottle, closing it.

Press the bottle. What is happening?

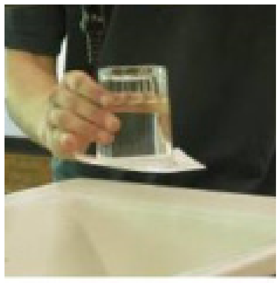
EXPERIMENT 6

Fill a glass completely with water.

Place a piece of paper or plastic on it. It must be bigger than the glass´s mouth.

Put your hand on the paper and turn the glass.

Move your hand and observe what happens.

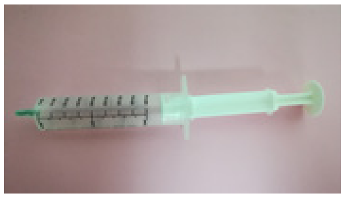


EXPERIMENT 7

Pull the piston of a syringe back.

Hammer the syringe into a plasticine piece and separate from it. Make sure that a piece of plasticine remains in the syringe mouth.

Push the piston now. What happens?



EXPERIMENT 8

Start with a syringe piston full pushed in.

Hammer the syringe into the plasticine piece and separate from it. Be sure that a piece of plasticine remains in the syringe mouth.

Pull back the piston now. What happens?

EXPERIMENT 9

Fill a bottle completely with water.

Place a ping-pong ball on its mouth.

Put your hand on the ball and press it on the bottle.

Turn the bottle.

Move your hand off and observe what happens

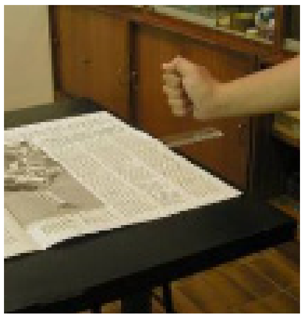
EXPERIMENT 10

Take a long ruler and put it on a table letting around 10 cm out of the table.

Open a newspaper on the table covering the ruler.

Try to lift the newspaper sheet with a short and strong blow on the ruler. Can you lift it?

Blend the newspaper several times and repeat the experiment. Can you lift it now?



After watching each video, try to complete the chart below:

EXPERIMENT	Explanation basing in kinetic molecular theory	Is it related to any law?
E1		
E2		
E3		
E4		
E5		
E6		
E7		

After watching all the videos, the students will explain to their classmates their experiment considering kinetic molecular theory or the corresponding law.

8. READING COMPREHENSION: WATER AND METEOROLOGY

Water is probably the most important chemical compound in our world. As you should already know, water covers almost ¾ of earth's surface (71%) and the human body is made up of 70% of water (that is the reason why it is so important to drink water every day and keep your body hydrated).

6 CLEAN WATER AND SANITATION

Of course, to make life in our planet possible, air must have also water in it, but not liquid water, vapour water. The amount of vapour water in the atmosphere depends on the area, there is few vapour on deserts and a lot inside clouds and fogs.

One example of vapour water in the atmosphere is fog. Fog consists in tiny droplets of water or ice crystals suspended in the air or near to the Earth surface and dense enough to reduce visibility to less than one kilometre.

Other important phenomena related to vapour in the atmosphere are dew, rime frost and hoarfrost.

In very humid nights, dew is formed due to the falling of temperature, as part of water vapour condensates on surfaces. You can see dew mainly on plants, but also on other surfaces. Rime frost is produced in foggy nights of winter, when ice spiky formations are formed on cool surfaces, while hoarfrost is composed of tiny ice crystals produced in clear nights when temperature drops below cero and dew freezes.

Vapour water is also very important in meteorology because it allows scientists to make weather forecast.

An example on how the vapour water can be used in these predictions is the vapour trails from airplanes.

When a plane is flying high, it is surrounded by very cold air. The gases that the plane expels are very hot and when they get in contact with the freezing air the water vapour that they have and that already existed in the air quickly condensates forming a kind of cloud that we call contrail (condensation trail).

The formation of contrails depends, among other factors, on the humidity of the air that surrounds the plain. If after a few days without watching contrails you start seeing them, it means that the air is damper and that the weather is going to change.

Therefore, contrails may be used to predict weather changes.

After reading the text, answer the next questions:

1. Why is it so important to drink water every day? Do you know how many glasses of water are recommended?
2. Where does the vapour water in the air come from?
3. Why do you think there is few vapour water in deserts?
4. What is dew? Where does it come from?
5. What is the difference between hoarfrost and rime frost?
6. What is a contrail? How is it formed?
7. How this can be used to predict weather?

9. VOCABULARY REVIEW

Matter | Material System | General / specific properties | Tiny particles | Cohesion/attractive forces

	Sublimation →					
	Solid		Liquid		Gas	
Square prism Cylinder Sphere	Joined Stick Ordered Vibrating particles	Melting	Joined Displacing particles	Vaporization Evaporation Boiling	Separating Displacing particles	Gas laws To remain Speed Rate Collisions Frequency
	Fixed position Strong forces Fixed shape Defined volume Slightly compressed	→ Melting point Freezing ← Solidification	Medium forces Container shape Definite volume Slightly compressed To flow To spread	→ Boiling point Condensation ← Liquefaction	Low forces Freely moving To fill the container To flow To expand	
Hot			come into come out			

10. FINAL ACTIVITIES

36. Explain, using the Kinetic Theory, what is pressure and what is temperature. What happens to pressure if temperature increases? Why?

37. The density of certain substance is 0,88 g/cm^3. Calculate the mass of that substance that fits in a flask of 100 mL.

38. The density of air is 1,18 kg/m^3. Calculate the mass of air that there is in a room with the following dimensions: 5m x 3 m x 2 m.

39. We put a piece of certain metal inside a graduated cylinder filled with water and it displaces a volume of 20 mL. If it has a mass of 54 g, what will be its density? Check in the table 2.A, what is that material?

40. We have a gold ingot and we want to know if it is real. To check it we measure its dimensions (30 cm X 10 cm x 3 cm) and we weigh it (17,37 kg) Calculate its density and decide, looking to table 2.A, if it is real gold or not.

41. If a piece of silver has a volume of 20 mL. What will be its mass? (Take the density of silver from table 2.A)

42. The volume of certain gas at 20ºC and 5 atm is 50L. What volume will occupy at 1 atm if we keep the temperature constant?

43. At what temperature is it necessary to heat 3 L of air to double its volume if the pressure is constant and the initial temperature is 0ºC?

44. Certain gas occupies 10 L at 2 atm and 0ºC. At what pressure will occupy a volume of 10 L if the temperature doesn't change? Write the result in mmHg.

45. There is a gas inside a recipient that occupies a volume of 2 L at 20ºC and 5 atm. What pressure there will be in the recipient if the final volume is 1 L and the temperature 50ºC?

46. A piece of glass has a mass of 24 kg. What volume does it occupy? Express in cm^3.

47. Does 1 kg of iron always occupy the same volume? And 1 kg of oil? And 1 kg of air? Explain the answers taking in mind the Kinetic-Molecular Theory

48. A cylinder made of silver has a radius of 2 m and a high of 4,5 m. Calculate its mass in g.

49. Calculate your volume using data from table of densities.

50. Under a pressure of 1 atm an ideal gas occupies a volume of 3 L. Which volume would it have under a pressure of 3 atm if the temperature remains unchanged?

How much have you learnt?

51. The boiling point of a substance is 90ºC and the melting point is 10ºC.

At 100ºC the substance is in .... state and its particles are .... and ....

At 50ºC the substance is in .... state and its particles are .... and ....

At 0ºC the substance is in .... state and its particles are .... and ....

52. Explain how you can measure the mass and volume of an irregular solid. How can you calculate its density?

53. Calculate the volume of the following pieces:

a. a cube with an edge of 2 cm

b. a sphere with a radio of 2 cm

54. If the solids in 2 are made of nickel, calculate their mass.

55. Complete the following sentences:

a. Specific properties of a material system depend on ....they are made of.

b. Changing of state of aggregation is a physical process consisting in ....

c. Changing from liquid to gas is called .... This process takes place in two different ways: .... and ....

56. Camphor balls are used to avoid the presence of moths. Which change of state takes place when they are in contact with the air?

57. Explain how you can directly measure the volume of an irregular object. How can you measure its mass? How can you calculate its density?

58. How can you calculate the volume of a cubic object with an edge of a m? How can you calculate the volume of a spherical object with a radius of r m?

59. Why solids expand while heating? Does this process happen to liquids and gases too? Take in mind the Kinetic-Molecular Theory.

60. Three quarters of a litre of a liquid have 600 g of mass. Calculate the density of the liquid in g/cm³ and kg/m³

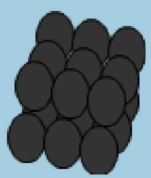
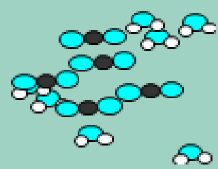
61. When we heat 25 cm³ of a gas contained in a balloon from 25ºC to 80ºC the volume of the gas reaches .... cm³

UNIT 3.
PURE SUBSTANCES AND MIXTURES. ELEMENTS AND COMPOUNDS

1. PURE SUBSTANCES AND MIXTURES

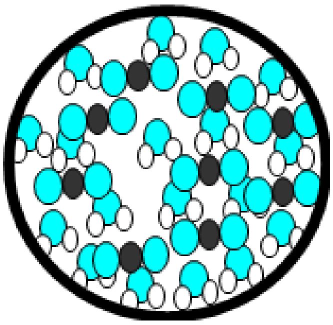
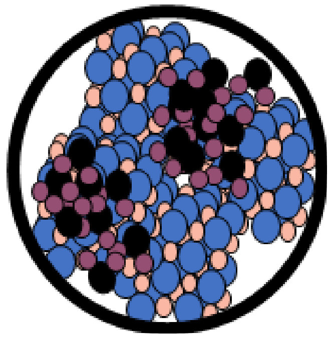
Matter can be classified into two categories: Pure substances and mixtures

Most of the material systems found in nature are mixtures of pure substances. But, which are the differences between a pure substance and a mixture? Look at the table below:

Material Systems	
Pure substance	**Mixture**
	
It cannot be separated into several substances by physical or mechanical means.	It can be separated into two or more substances by physical or mechanical means.
It is homogeneous, has constant and uniform composition throughout the whole sample.	Its composition can be varied by changing the proportion of pure substances making it up.
Its specific properties (density, boiling point, melting point, etc.) are constant throughout the whole sample.	It shows the properties of the pure substances which make it up.
Examples: • Pure water • Gold • Iron • Sodium chloride • Calcium oxide	Examples: • Atmosphere, mixture of gases • Wine, mixture of water and alcohol • Soft drinks, mixture of carbon dioxide and water. • A piece of rock or a handful of sand, mixture of solids.

Mixtures can be divided into two types. The difference between them is the degree at which the materials are mixed:

A ***homogeneous mixture*** is made up by components uniformly distributed throughout the mixture while components in ***heterogeneous mixture*** can be easily distinguished.

Homogeneous mixture	Heterogeneous mixture
	

Pure substances are divided into two different categories:

- ***Elements:*** Are pure substances made up the same type of atoms and which cannot be separated into simpler substances by chemical reactions.
- ***Compounds:*** Are pure substances made up atoms of two or more different elements and can be separated into simpler substances by chemical reactions.

All the elements known are included in the "Periodic Table of Elements". You can check if a pure substance is an element looking for its name in it.

A compound usually has a name made of two words: for example, calcium chloride, nitric acid, barium sulphate or carbon dioxide are compounds.

Practice the density concept solving the following problems:

1. Classify the following substances in mixtures (homogeneous or heterogeneous) or pure substances (element or compound):

Sand

Bronze

Oxygen

Copper

Salty water

Sodium chloride

Distilled water

Water of the river

Water you drink

Orange juice

2. Complete the sentences:

a. A pure substance is a sort of material system which:

i. ....

ii. ....

iii. ....

b. An element is a sort of .... which ....
....

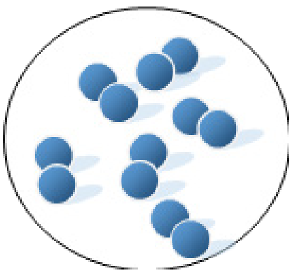
c. A compound is a sort of .... which ....
....
....

d. A mixture is a sort of .... which ....
....

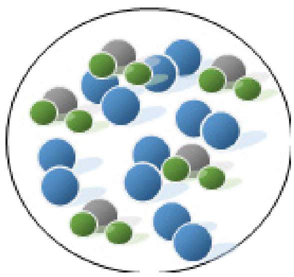
e. A mixture can be .... and ....

3. Look at the drawings and classify as homogeneous mixture, heterogeneous mixture, element or compound:

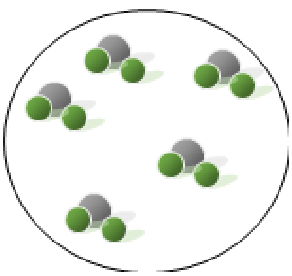
A.



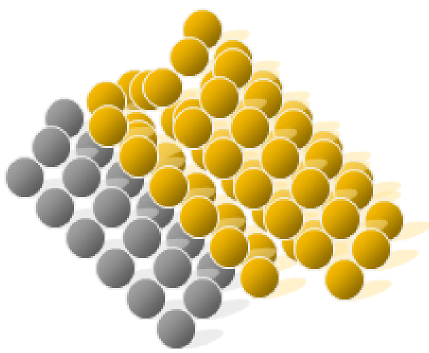
B.



C.



D.



2. SOLUTIONS: COMPONENTS AND TYPES

A homogeneous mixture also is called ***solution***. A solution is made up a ***solvent*** and one or more different ***solutes***. The solvent is the substance which does the dissolving and the solutes are the substances dissolved into the solvent.

Depending on the state of the solvent solutions can be divided into the types below:

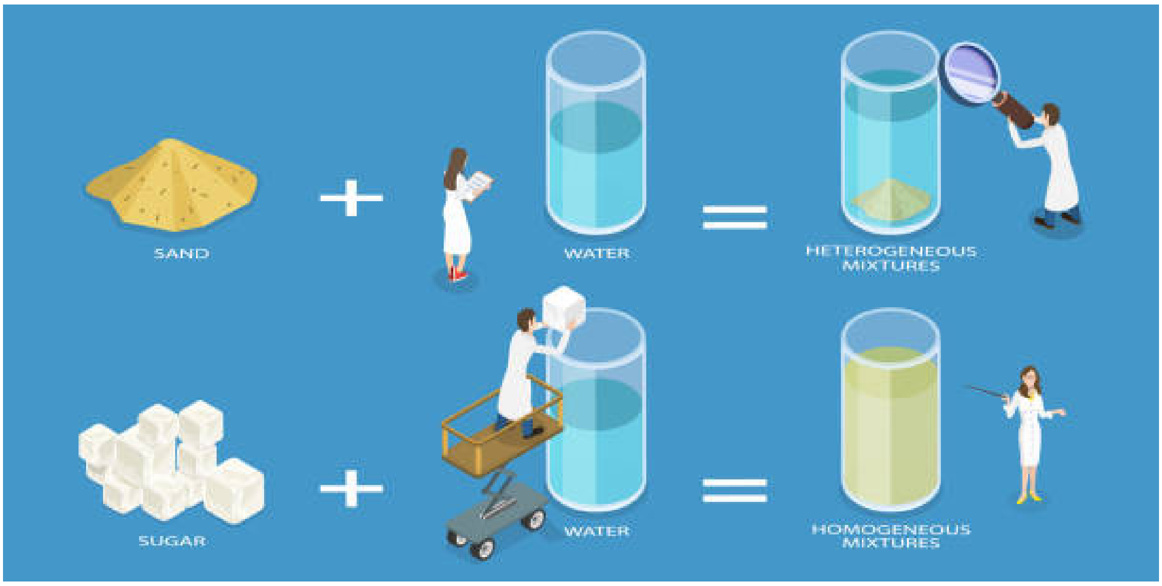
Types of solutions			
Solution	Solvent	Solute	Examples
Solid	Solid	Solid	Alloy of copper and tin (bronze)
		Liquid	Amalgam of mercury and golden
		Gas	Hydrogen adsorbed by platinum
Liquid	Liquid	Solid	Sugar in water
		Liquid	Alcohol in water
		Gas	Oxygen in water
Gas	Gas	Solid	Sublimated Iodine in the air
		Liquid	Water in the air
		Gas	Air

Solubility of a solute in a solvent is its ability to dissolve in the solvent.

A substance with an extremely small solubility in a solvent is **non soluble**.

When a liquid is completely able to dissolve in another liquid the two ***liquids*** are ***miscible***.

While, when two liquids are unable to mix and form a solutions the two ***liquids*** are ***immiscible***.



2.1 Concentration of a chemical solution

Concentration of a solution is defined as the amount of solute that is dissolved in a portion of solution.

$$Concentration = \frac{amount\ of\ solute}{amount\ of\ solution}$$

The amount of a substance can be expressed by the two general properties of the matter, mass or volume.

Depending on that fact the concentration of a solution can be expressed in three different ways:

- **Mass percentage:** It expresses the mass of solute that is solved in 100 g of solution

$$\%\ volume = \frac{solute\ (cm^3)}{solution\ (cm^3)} \cdot 100 \quad \text{or} \quad \%mass = \frac{solute(g)}{solute(g)+solvent(g)} \cdot 100$$

- **Volume percentage:** It expresses the volume of solute that is solved in 100 cm³ of solution

$$\%\ volume = \frac{solute\ (cm^3)}{solution\ (cm^3)} \cdot 100 \quad \text{or} \quad \%\ volume = \frac{solute(cm^3)}{solute(cm^3)+solvent(cm^3)} . 100$$

Another unit of volume can be used but notice than solute and solution need to be expressed in the same unit.

- **Mass of solute into volume of solution:** It expresses the mass of solute that is solved in a litre of solution

$$Concentration\ (^{g}/_{L}) = \frac{solute\ (g)}{solution(L)}$$

But, how are these equations used? Look at the examples:

1. What is the concentration of a solution obtained mixing 2,5 g of sugar into 150 g water?

DATA

Solute (Sugar) 2,5 g

Solvent (water) 150 g

Solution (sugar + water) 152,5 g

Concentration?

Solving method

All data have been given in mass so we only can use concentration in %mass.

$$\%mass = \frac{solute(g)}{solution(g)} .100$$

$$\%mass = \frac{2{,}5g}{152{,}5g} .100 = 1{,}64\%mass$$

Which means than the solution has 1,64 g of sugar into 100 g

2. Imagine you mix 300 L of a pure alcohol and 500 L of water. What is the concentration of the solution obtained?

DATA

Solute (alcohol) 300 L

Solvent (water) 500 L

Solution (alcohol + water) 800 L

Concentration?

Solving method

All data have been given in volume (L) so we only can use concentration in %volume

$$\%volume = \frac{solute(L)}{solution(L)} .100$$

$$\%volume = \frac{300L}{800L} .100 = 37{,}5\%volume$$

Which means than the solution has 37,5 L of alcohol into 100 L

3. We have a bottle of 750 cm³ full of sweet water with a concentration of sugar of 5g/L. How much sugar has the bottle inside?

DATA

Solute (sugar)?

Solvent (water)

Solution (sugar + water) 750cm³

Concentration 5g/L

Solving method

Concentration is expressed in g/L so: firstly, we need to express volume of solution in L

$$750\ cm^3 . \frac{1\ L}{10^3 cm^3} = 0{,}75\ L$$

$$C(g/L) = \frac{solute(g)}{solution(L)} .100$$

$$5g/L = \frac{solute(g)}{0{,}75L}$$

$$solute(g) = 5\ {}^{g}/_{L} . 0{,}75L$$

$$solute(g) = 3{,}75g\ of\ sugar$$

Practice the density concept solving the following problems:

4. Which is the concentration of a solution prepared when 3 g of sugar is added to 200 g of water?

5. Imagine you mix 35 ml of alcohol with 250 ml of water. Which is the concentration of the solution?

6. Calculate the concentration of a solution prepared when 5 g of salt is added to 200 mL of water. Remember that the density of water is 1g/mL.

7. An amalgam has 300 g of gold and 3 g of mercury. Calculate its concentration

8. Calculate the concentration of the solution, in mass percentage, prepared by adding 25 g of sugar to a bottle of water with a volume of 750 cm³.

9. You must prepare 300 mL of a solution of Sodium hydroxide (NaOH) in water with a concentration of 10 g/L .Which mass of Sodium hydroxide do you need?

10. In a bottle of 750 cm³ of wine you read that the concentration of alcohol is 11% in volume. How much alcohol is there in the bottle?

11. You have 500 g of bronze with a concentration of cupper of 25% in mass. What is the mass of cupper and tin in the alloy?

12. A sample of 200 g of platinum has adsorbed 3 g of hydrogen. Calculate the concentration of hydrogen in the sample.

13. The concentration of oxygen in the air is 21% in volume. Calculate the volume of oxygen in a room which volume is 80 m³.

3. SEPARATION OF MIXTURES

A separation is a physical process which consists in the conversion of a mixture in two or more different pure substances. Several separation processes can be used depending on the characteristics of the mixture of substances. The following table shows a summary of separation processes and relates each one with the sort of mixture than can separate and the property used for doing it. An example of each one is included:

Separation technique	Used for separating mixtures of:	Property used for separation	Example
Sieving	Solids	Particle size	Alluvial gold from smaller soil particles
	Gases		Oxygen from nitrogen: carbon molecular sieve
Visual Sorting	Solids	Colour, shape, size	Gold nuggets from rock
Magnetic attraction	Solids	Magnetism	Iron from non-magnetic solids
Sublimation	Solids	Ability of sublimate	Iodine from salt
Flotation	Solids	Density	Cork from sand
Decanting	Liquid and non-soluble solid	Density	Water from sand
	Immiscible liquids		Oil from water
Filtration	Liquid and non-soluble solid	Solubility	Water from sand
Evaporation	Liquid and soluble solid	Boiling point	Salt and water
Crystallization		Solubility	Slightly soluble sulphate from water
Distillation	Miscible liquids	Boiling point	Alcohol from water

4. LEARNING SITUATION: SEPARATION OF MIXTURES

The best way of learning separation techniques is practicing them. That is why several laboratory activities are proposed in the following pages:

LABORATORY ACTIVITY 1. Separating substances from a mixture of solids.

OBJECTIVES:

1. To use several techniques for separating solids
2. To know and handle the materials used for separating solids from a mixture

MATERIAL:

BEAKER, AGITATOR STICK, SPATULE, FILTER PAPER, FUNNEL, CONICAL FLASK, MAGNET, WATCH GLASS, CRYSTALLIZER.

EXPERIMENTAL WORK:

You have to separate a mixture of salt, sand, iron filings and cork. Before starting to work think and answer the following questions?

1. **Are any of the substances attracted by a magnet?**
2. **Which of these four substances is soluble in water?**
3. **Which method of separation can be used to separate cork and sand?**
4. **Based on your answers, make a scheme of the separating methods you are going to use. Think that ordering the steps is important to get good results.**
5. **Do the separation practice. Then, draw and explain which materials you have used in each step of the practice.**

LABORATORY ACTIVITY 2. Separating substances from a mixture of miscible liquids.

OBJECTIVES:

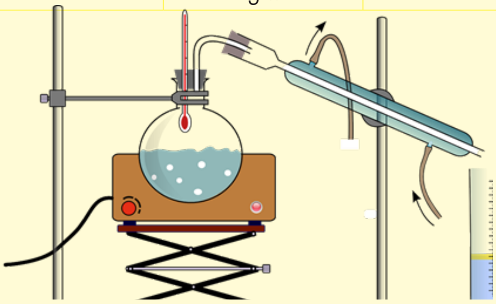
1. To know how to do the assembly needed for distillation
2. To understand how the distillation process works

EXPERIMENTAL WORK:

Wine is a mixture of substances, mainly water and alcohol. The method used to separate them is named **DISTILLATION** that is based on differences in volatilities of components in a boiling liquid mixture. Simple distillation is usually used only to separate liquids whose boiling points differ greatly (25 °C), or to separate liquids from solids.

1. **Look at the assembly, draw it and name each part using the following words:**

Burner	*Still head*	*Cooling water out*
Distillation flask	*Condenser*	*Receiving flask*
Thermometer	*Cooling water in*	*Distillate*



2. **Before lighting the burner, observe and note down the temperature of the mixture**
3. **Light the burner, observe the process and answer**
   - 3.1. Observe the thermometer. What is happening?
   - 3.2. Which temperature has the mixture when boiling starts?
   - 3.3. Does the temperature remain constant?
   - 3.4. Explain the process that you observe
   - 3.5. Which temperature the thermometer stops at? What does it happened at this temperature?

LABORATORY ACTIVITY 3. Separating substances from a mixture of immiscible liquids.

OBJECTIVES:

To know how to use the separation funnel for separating a mixture of immiscible liquids.

MATERIAL:

BEAKERS or CONICAL FLASKS, SEPARATING FUNNEL, WATER, OIL.

EXPERIMENTAL WORK:

Decanting is a separating process based in the density of substances. Oil is an organic liquid with a density lower than water and which cannot be mixed with it.

1. Observe the separating funnel and make a drawing indicating these two parts: stopper, tap.
2. Transfer into the funnel 20 mL of water, using a pipette.
3. Transfer now in the same way 20 ml of oil. Observe that water and ether are immiscible. Add in your drawing the two liquids and explain why oil is on top of water.
4. Put a beaker bellow the funnel and open the tap. Let water flow into the beaker and close the tap.
5. Remove the beaker with water and put another beaker below the funnel.
6. Let the interface flow into the second beaker and the remove it.
7. Do the same in a third beaker and let the oil flow into it.

LABORATORY ACTIVITY 4. Solubility for purifying copper sulphate.

OBJECTIVES:

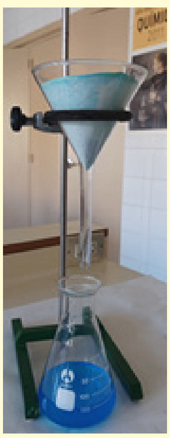
To clean impure copper sulphate using solubility as separating method.

MATERIAL:

BEAKERS,CONICAL FLASKS, FUNNEL, FILTER, WATER, CHRYSTALIZER.

EXPERIMENTAL WORK:

CRYSTALLIZATION: It is a separating method to obtain a solid that is solved into a liquid. We are going to purify copper sulphate, separating it from its impurities by solubility that is a process that uses filtration and crystallization. We start solving the solid into water. Explain how the solution is.



a. Name in the image the laboratory material we use to separate copper sulphate from the impurities

b. What does the filter retain? Why?

c. What separating method are we using?

d. Compare the initial solution with the filtered one. What difference can you observe?

e. How are we going to separate the copper sulphate from the water?

f. How are the crystals obtained?

g. Explain crystallization process with your own words

LABORATORY ACTIVITY 5. Working with solutions.

You will improve your knowledge about solution, practicing with the following laboratory activities:

OBJECTIVES:

1. To practice techniques for preparing solutions
2. To make the needed calculations to prepare the right solution or calculate the concentration of the prepared solution
3. To know and handle the materials used for preparing solutions

MATERIAL:

BEAKER, AGITATOR STICK, FUNNEL, VOLUMETRIC FLASK, WATCH GLASS, WASHING BOTTLE, SPATULE, BALANCE, PIPETE, BURETE, DRIPPING BOTTLE, SALT, WATER.

EXPERIMENTAL WORK:

Labority activity 5.1

1. **Weight around 20 g of salt using a watch glass. Note down the exact weight ....**
2. **Transfer the solid into a beaker. To avoid losing salt, clean the watch glass with water and transfer it also to the beaker.**
3. **Stir using the agitator stick to complete solution.**
4. **Before adding the solution to the volumetric flask, weight the mass of the empty and note down its mass.**

Volumetric flask mass =..........................

5. **Transfer the solution to the flask using the funnel. Add some more water till the volumetric mark. Use a funnel if it is necessary. Weight the mass of the full flask. Calculate the mass of the solution and note down the following information:**
   - Flask + solution mass= ....
   - Solution mass= ....

6. **Think about the information you have and complete the table below**

	Mass (g)	Volume (mL)
Solute (...........................)		
Solvent (...........................)		
Solution (..............+...........)		

7. **Calculate the concentration of the solution prepared in two possible ways.**

Labority activity 5.2

Prepare 100 mL of a solution which concentration in salt is 30 g/L. Firstly you have to calculate the mass of salt. After that, follow the experimental steps of Laboratory activity 5.1.

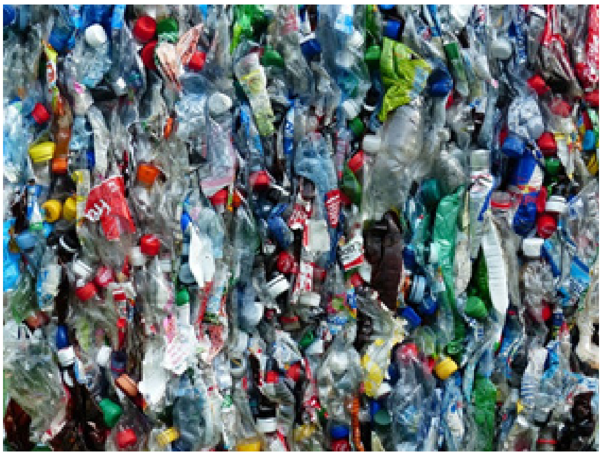
5. READING COMPREHENSION. THE THREE R´S: "REDUCE, REUSE AND RECYCLE" WASTE HIERARCHY

In this unit we have studied matter. All the objects we use are made of matter and at the end of their life they turn into waste that is accumulated in the environment for long periods of time.

Have you ever heard of something called the "waste hierarchy"? It is the order of priority of actions to reduce the amount of waste generated. It consists of 3 R´s: reduce, reuse, and recycle. Let´s see how to incorporate it into your daily life, so that less amount of waste goes to the landfill and you can reduce your carbon footprint.

For **reducing** items in your life that at the end are going to became waste, before buying a new one you should ask yourself "can something else be used for the same purpose?", "Is it really necessary to get it?". Think that a lot of our waste material comes from items that are considered unnecessary. Some reducing actions can be:

- Avoid using disposable plates, spoons, glasses, cups, and napkins. They result in a large amount of waste.
- Avoid buying items that are over-packaged with foil, paper, and plastic. This extra packaging goes to waste.
- Use refillable pens instead of buying too many.



Reusing consists in repurposing old items for a different use. One of the best examples of how this is being done today is the modular construction of homes and office buildings that are being created out of discarded shipping containers.

You can reuse for example old jeans, T-shirts or any clothes and turn into bags, doll´s clothes or cleaning rags. Other ways of reusing are donating old books or used clothes, repairing items rather than throw them or buying in second hand stores. If you have a garden, it is a good idea to build your own compost bin and make compost from your organic waste.

The last stage of the waste hierarchy is **recycling**. It consists in transforming an item into a raw material that can be shaped into a new item. However, you must know that not all the materials on the earth can be recycled.

When you buy products made of materials that can be recycled, you are in the first step towards efficient recycling. There is usually a recycling symbol on the bottom of products to know whether it is recyclable or not.

Another way of being environment friendly is using recycled paper whenever you can. And finally, you should separate your own waste to make recycling easier.

The main benefits of waste hierarchy are:

- A significant reduction in the amount of waste thrown into the environment.
- A decrease in the spreading of toxins and pollution of soil and water.
- The reduction of levels of greenhouse gas emission.
- A more sustainable energy consumption because excessive consumption is reduced.

Nowadays, another R is becoming important in companies and industries, **recovering** materials from waste that cannot be reduced, reused or recycled and convert them in electricity, heat, fuel or compost through thermal or biological methods.

Now, let´s talk about:

1. **Think about three ways of reducing at home or at school.**
2. **Think about three ways of reusing.**
3. **How can we help in recycling process?**

6. VOCABULARY REVIEW

VOCABULARY: METHODS FOR SEPARATING MIXTURES OF										
Solids				**Liquid and a no-soluble solid**		**Liquid and a soluble solid**		**Immiscible liquids**	**Miscible liquids**	**Gases**
Magnetic attraction	**Sublimation**	**Flotation**	**Solubility**	**Decanting**	**Filtration**	**Crystallization**	**Evaporation**	**Decanting**	**Distillation**	**Selective adsorption**
Magnet Iron filings	Iodine Dry ice Camphor	To float To dive Cork	Soluble No-soluble Solution Solvent Solute To solve	Sand Sedimentation	To go through	Evaporation Saturation of solution Solubility limit Crystals grow	Salt works To remove the liquid To leave the solid	Oil /water To drop To flow Dripping of	Alcohol Water Boiling point Volatility Distillate	Porous materials
		Spatula	Agitator stick Beaker Funnel Filter		Beaker Funnel Filter paper	Crystallizer		Separating funnel Valve /tap Stopper	Burner Distillation flask Still head Condenser Cooling water in/out Receiving flask Still receiver	Molecular sieves

7. FINAL ACTIVITIES

14. List the differences between a pure substance and a mixture

15. Classify the following chemical systems into heterogeneous mixture, homogeneous mixture or pure substance:

- Water and salt
- An alloy of copper and nickel
- Smoke
- Wine
- Water
- Milk
- Air
- Bronze
- Nitrogen

16. In the kitchen you have the following ingredients: flour, sugar, olive oil, whipped eggs, vinegar, sunflower oil and water. Explain how will you prepare:

- o A heterogeneous mixture of two solids.
- o A heterogeneous mixture of two liquids.
- o A solution of a solid into a liquid.
- o A solution of one liquid into another

17. Explain which methods would you use to separate:

a. Salt and rice

b. Oil and vinegar

c. Vinegar and water

d. Iodine, plaster and iron filings

e. Oil, water and salt

18. A solution is prepared mixing of 40 mL of alcohol with water till filling a volume of 800 ml. Express the concentration of the solution in volume percentage

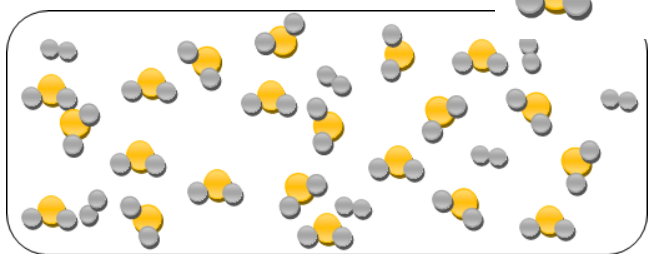
19. A solution is prepared solving 30 g of salt in 400 mL of water. Calculate the concentration in mass percentage.

20. A solution has a concentration of 250 g/L of salt in water. Calculate the mass of salt which contains a glass of 200 cm^3.

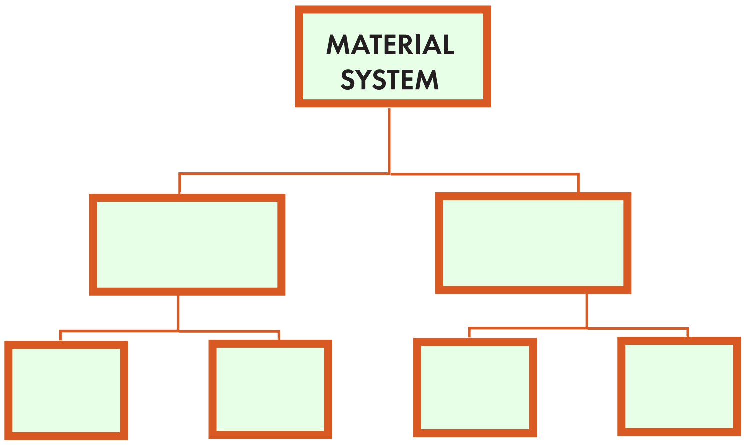
21. Complete using the words of the chart below:

Pure substance	*solution*	*components*	*homogeneous mixture*	
heterogeneous mixture	*solvent*	*solute*	*element*	*compound*

The picture below represents a ...., also known as .... It is composed of two .... A represents an .... and could be considered as a .... B represents a ....
And could be considered as a ....



22. Complete:



22. Decide if the sentences about a solution whose concentration is 300 g/L are true or false:

a. A litre of solution has a mass of 300 g

b. There are 300 mg of water in 1 mL of solution

c. There are 300 mg of solute in 1 mL of solution

d. There are a litre of water in a litre of solution

23. To prepare a soup 16 g. of salt must be added to 2 L of water.

a. What's the concentration (in g/L) of salt in the soup?

b. If we take 150 mL of soup, what will be its concentration?

c. How much salt there will be in those 150 mL?

24. To prepare a soup 16 g. of salt must be added to 2 L of water.

a. What's the concentration (in g/L) of salt in the soup?

b. If we take 150 mL of soup, what will be its concentration?

c. How much salt there will be in those 150 mL?

25. Glucose, one of the sugar's compounds, is a solid substance soluble in water. The solution of glucose in water (serum) is used to feed sick people when they can't eat. In the label of a 500 cm^3 serum's bottle it is written "Solution of glucose in water, concentration 55 g/L".

a. Which one is the solute and which one the solvent?

b. We put 50 cm^3 of the solution in a dish. When the water evaporates, how much glucose will be on the dish?

c. A sick person needs to have 40 g of glucose per hour. How much serum must be given to him per hour?

26. In the label of an alcoholic drink we can read 13,5% vol.

a. What does that number mean?

b. If the bottle has a volume of 70 cL, how much alcohol does it contain?

27. As you know, metallic alloys are solutions in which their components are in solid state. To measure the concentration of gold in an alloy (the other component is usually silver) it is used a unit called carat. A concentration of 1 carat means that from each 24 g. of alloy, 1 g is pure gold.

a. What % mass correspond to an alloy of 1 carat?

b. What % mass will have an alloy of 18 carats? And one of 24?

c. Can an alloy of 30 carats exist? Why?

d. How much pure gold there is in a gold ingot of 24 carats of 4 kg?

28. In the lab there is a flask with HCl with a concentration of 35 % mass.

a. How much HCl there will be in a recipient of 1,5 kg?

b. What amount of solution should we take so it has 6 g of HCl?

29. We have a solution of sugar in water with an unknown concentration. We take with a pipette 10 mL of that solution, we put them in an evaporating dish and when the water evaporates there are 0, 65 g. of sugar left. What was the concentration of the solution? How much have you learnt?

How much have you learnt?

30. Think and join:

Sublimation	Iron filings and sand	Mixture of gases
Magnetic attraction	Water and oil	Mixture of immiscible liquids
Distillation	Water and alcohol	
Crystallization	Nitrogen and oxygen	Liquid and a soluble solid
Decanting	Salt and sand	
Solubility	Iodine and sand	Mixture of solids
Selective adsorption	Water and salt	Miscible liquids

31. Explain the techniques of separation mentioned in exercise 30.

32. Complete:

a. A .... is a material system with a defined composition and specific properties such as ...., ... and ....

b. A .... is a material system composed of two or more substances

c. In a .... components can be distinguished

d. In a .... mixture components cannot be distinguished.

e. A .... is a .... mixture composed by a .... and one or more ....

33. Decide if the sentences about a solution whose concentration is 30% mass are true or false:

a. 100 g of solution has a mass of 30 g

b. There are 700 g of water in 1 kg of solution

c. There are 30 g of solute in 1 L of solution

d. There are a litre of water in a litre of solution

34. A solution of KCl in water is prepared mixing 27 g of KCl into 400 mL of water. Calculate the concentration of the solution expressed in mass percentage.

35. From a solution whose concentration is 40% in mass a portion of 250 g has been separated. What amount of solute does the sample contain?

36. We have a solution of sugar in water with a concentration of 50 g/L. Which volume do we need to get 30 g of sugar?

37. Vinegar is a mixture of water and acetic acid. Calculate the mass of Acetic acid which is contained in 500 g of vinegar with a concentration of 4% in mass.

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UNIT 2. MATTER. PROPERTIES OF MATTER

1. MATTER. PROPERTIES OF MATTER. DENSITY

En este apartado se define material, sistema material y propiedad específica, introduciendo la densidad como tal. El principal objetivo es que los alumnos entiendan que distintos sistemas materiales compuestos de la misma sustancia tienen la misma densidad. Un segundo objetivo es que los alumnos sepan resolver problemas de densidad en los que calculen cualquiera de las tres magnitudes implicadas, masa, volumen y densidad. Se presentan tres problemas tipo como ejemplos.

Se presenta la resolución de los problemas organizada, colocando los datos a la izquierda y la resolución del problema a la derecha. Se recomienda que el profesor insista en que los alumnos sigan el mismo sistema para la resolución.

Practice the density concept solving the following problems:

1. Taking in mind Table 2.A, express the densities of gasoline, sand and lead in the International System unit.

Density of gasoline:

$$\frac{0{,}72\ g}{1cm^3}\cdot\frac{1\ kg}{10^3 g}\cdot\frac{10^6 cm^3}{1m^3}=\mathbf{720\ ^{kg}/_{m^3}}$$

Density of sand:

$$\frac{2{,}80\ g}{1cm^3}\cdot\frac{1\ kg}{10^3 g}\cdot\frac{10^6 cm^3}{1m^3}=\mathbf{2800\ ^{kg}/_{m^3}}$$

Density of lead:

$$\frac{11{,}30\ g}{1cm^3}\cdot\frac{1\ kg}{10^3 g}\cdot\frac{10^6 cm^3}{1m^3}=\mathbf{11300\ ^{kg}/_{m^3}}$$

2. Calculate the density of an object whose mass is 10,5 g and that occupies a volume of 5 cm³. Express it in g/cm³ and kg/m³.

Data	**Solving method**
m= 10,5 g V= 5 cm³ D= ?	$D=\frac{m}{V}$ $D=\frac{10{,}5g}{5cm^3}=2{,}1\ ^{g}/_{cm^3}$

$$\frac{2{,}1\ g}{1\ cm^3}\cdot\frac{1\ kg}{10^3 g}\cdot\frac{10^6 cm^3}{1m^3}=\mathbf{2100\ ^{kg}/_{m^3}}$$

3. The density of a substance is 1200 kg/m³ and its mass is 24 kg. Can you know its volume? Express it in cm³.

Data	**Solving method**
m= 24 kg V= ? D= 1200 kg/m³	$D=\frac{m}{V}$ $1200\ ^{kg}/_{m^3}=\frac{24\ kg}{V}$ $V=\frac{24\ kg}{1200\ ^{kg}/_{m^3}}=0{,}02\ m^3$ $0{,}02\ m^3\cdot\frac{10^6 cm^3}{1m^3}=\mathbf{2\cdot 10^4 cm^3}$

4. The density of a liquid is 800 kg/m³. How many mass is contained in 0,5 m³? Express it in g.

Data	**Solving method**
m= ? V= 0,5 m³ D= 800 kg/m³	There is congruence among units so no unit conversions are needed $D=\frac{m}{V}$ $800\ ^{kg}/_{m^3}=\frac{m}{0{,}5m^3}$ $m=0{,}5\ m^3\cdot 800\ ^{kg}/_{m^3}=400\ kg$

$$400\ kg\cdot\frac{10^3 g}{1\ kg}=\mathbf{4\cdot 10^5 g}$$

5. 3 cubic centimetres of a liquid have a mass of 5 grams. Determine its density in kg/m³.

Data	**Solving method**
m= 5 g V= 3 cm³ D= ?	$D=\frac{m}{V}$ $D=\frac{5g}{3cm^3}=1{,}67\ ^{g}/_{cm^3}$

$$\frac{1{,}67\ g}{1\ cm^3}\cdot\frac{1\ kg}{10^3 g}\cdot\frac{10^6 cm^3}{1m^3}=\mathbf{1670\ ^{kg}/_{m^3}}$$

6. An object made of copper occupies a volume of 4 dm³. Calculate its mass in grams. (take the density of the table 2.A).

Data	Solving method
m= ?	Firstly, volume has to be converted in cubic centimetres:
V= 4 dm³	$4dm^3 \cdot \frac{10^3 cm^3}{1\ dm^3} = 4000\ cm^3$
D= 8,63 g/cm³	$D = \frac{m}{V}$
	$8{,}63\ ^{g}/_{cm^3} = \frac{m}{4000\ cm^3}$
	$\boldsymbol{m} = 4000\ cm^3 \cdot 8{,}63\ ^{g}/_{cm^3} = \mathbf{34520\ g}$

7. Three litres of a liquid have a mass of 2 kg. Calculate its density in g/cm³.

Data	Solving method
m= 2 kg	Firstly we need to convert volume in cubic centimetres and mass in grams
V= 3 dm³	$3 \cdot \frac{10^3 cm^3}{1\ dm^3} = 3000\ cm^3$
D= ?	$2\ kg \cdot \frac{10^3 g}{1\ kg} = \mathbf{2 \cdot 10^3 g}$
	$D = \frac{m}{V}$
	$D = \frac{2000g}{3000cm^3} = \mathbf{0,67}\ ^{\boldsymbol{g}}/_{\boldsymbol{cm^3}}$

8. A cube made of lead has an edge of 7 cm. Calculate its mass in kg. (take the density of the table 2.A)

Data	Solving method
m= ?	Firstly, volume has to be calculated:
L= 7 cm	$V = l^3 = (7cm)^3 = 343\ cm^3$
D= 11,3 g/cm³	$D = \frac{m}{V}$
	$11{,}3\ ^{g}/_{cm^3} = \frac{m}{343cm^3}$
	$m = 343\ cm^3 \cdot 11{,}3\ ^{g}/_{cm^3} = 3875{,}9\ g$

$$3875{,}9\ g \cdot \frac{1\ kg}{10^3 g} = \mathbf{3,876\ kg}$$

9. A cylinder with a radius of 5 cm and a height of 7 cm has a mass of 450 g. Calculate de density of the substance it is made of. Does it float on water?

Data	Solving method
m= 450 g	Firstly we need to calculate the volume of the cylinder
R= 5 cm	$V = \pi \cdot r^2 \cdot H$
H=7 cm	$V = \pi \cdot (5\ cm)^2 \cdot 7\ cm$
D= ?	$V = 549{,}8\ cm^3$
	$D = \frac{m}{V}$
	$D = \frac{450g}{549{,}8cm^3} = \mathbf{0,819}\ ^{\boldsymbol{g}}/_{\boldsymbol{cm^3}}$

As the density is smaller than the density of water, the cylinder floats on it.

10. A sphere made of granite, has a radius of 8 m. Calculate its mass in kg. (take the density of the table 2.A).

Data	Solving method
m= ?	Firstly, volume has to be calculated:
R= 8 m	$V = \frac{4}{3} \cdot \pi \cdot r^3 = \frac{4}{3}\pi(8\ m)^3 = 2144{,}7\ m^3$
D= 2,650 g/cm³	Secondly, density has to be expressed in kg/m³:
	$\frac{2{,}650\ g}{1\ cm^3} \cdot \frac{1\ kg}{10^3 g} \cdot \frac{10^6 cm^3}{1m^3} = 2650\ ^{kg}/_{m^3}$
	$D = \frac{m}{V}$
	$2650\ ^{kg}/_{m^3} = \frac{m}{2144{,}7\ m^3}$
	$m = 2144{,}7\ m^3 \cdot 2650\ ^{kg}/_{m^3} = 5{,}68 \cdot 10^6\ \mathbf{kg}$

11. A square prism has edges of 5cm, 10 cm and 15 cm. It is made of a wooden whose density is 850kg/m³. Calculate its mass.

Data	Solving method
m= ?	Firstly, volume has to be expressed in m³:
V= 5 cm·10cm·15 cm	$750\ cm^3 \cdot \frac{1\ m^3}{10^6 cm^3} = 7{,}5 \cdot 10^{-4} m^3$
V=750 cm³	$D = \frac{m}{V}$
D= 850 kg/m³	$850\ ^{kg}/_{m^3} = \frac{m}{7{,}5 \cdot 10^{-4}\ m^3}$
	$m = 7{,}5 \cdot 10^{-4}\ m^3 \cdot 850\ ^{kg}/_{m^3} = \mathbf{0,638\ kg}$

2. STATES OF AGGREGATION OF MATTER: SOLID, LIQUID AND GAS

Se presentan los tres estados de agregación y sus propiedades resumidas en una tabla. Los cambios de estado están resumidos en un gráfico en el que se presentan en rojo aquellos procesos que necesitan calor y en azul los que desprenden calor.

A continuación, se clasifica la vaporización en dos procesos diferentes: la evaporación y la ebullición; se definen los dos procesos de modo que el alumno pueda compararlos.

Finalmente, se presentan las definiciones de temperatura de fusión y temperatura de ebullición, como otras dos propiedades específicas. En este punto se debe insistir que durante un cambio de estado la temperatura del sistema permanece constante. El gráfico adjunto ayuda a su comprensión.

Se pide la resolución de unos ejercicios lógicos sobre cambios de estado.

Exercises:

12. Explain why clothes dry faster when they are hanged in the rope than when they are left in the bucket.

A bigger surface is in contact to the air.

13. When you take a hot shower the bathroom usually gets full of steam. But why the mirror is steamed up?

Part of the hot water evaporates and spreads in the air, but when vapour meets a surface as the mirror with lower temperature it condensates on it.

14. In winter, many mornings the windscreens of some cars are frozen. Explain this phenomenon.

Water vapour in the atmosphere one condensed on the surfaces can freeze if temperatures are under cero degrees.

15. Some fridges have ice on the back of them. Where does this ice come from?

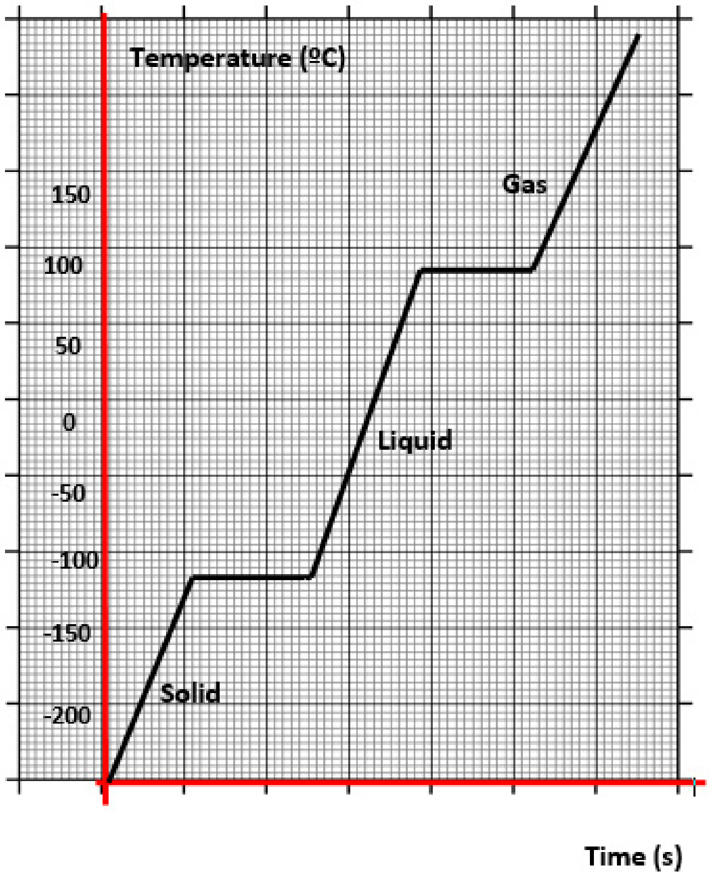
It is water vapour from the atmosphere that condensates and freezes under cero degrees.

16. We have said the boiling point depends on the pressure. That is the principle of working of the pressure cooker. Try to explain with your own words why the pressure cooker cooks faster than normal casseroles.

Pressure inside the pressure cooker is higher. As a consequence, boiling temperature is higher. The higher is the temperature the faster is the cooking process.

17. The next graphic shows the change of states with the time of alcohol. Mark the three states of matter on the graphic and write the melting and the boiling point of that substance.

- Melting point =-115ºC
- Boiling point = 85ºC



3. KINETIC MOLECULAR THEORY

Se resumen los puntos fundamentales de la teoría cinético-molecular y se presenta un cuadro de estados de la materia vistos desde esta teoría y la explicación de las propiedades de cada uno de los estados desde el punto de vista de la teoría.

De nuevo se repite el esquema de cambios de estado, pero en esta ocasión con el cambio interno en la estructura de las partículas que supone cada cambio de estado.

Se pide la resolución de ejercicios sobre las propiedades de los estados de agregación, los cambios de estado y la teoría cinético-molecular.

Se puede utilizar el siguiente enlace para la mejor comprensión:

https://phet.colorado.edu/sims/html/states-of-matter/latest/states-of-matter_all.html?locale=es

Practice the concepts with the following exercises:

18. Indicate the differences among the properties of solids and liquids, using table 2.B information

Solids have got fixed shapes while liquids have got the shape of the container.

Liquids can flow while solids cannot flow.

19. Summarize the differences among the properties of liquids and gases, using table 2.B information

- Liquids have got defined volumes while gases spread and fill the entire container.
- Liquids can be only slightly compressed while gases are easily compressed.
- Density values in liquids are high while density values in gases are low.

20. Complete the following sentences:

a. Melting temperature of Iron is 1539ºC . The state of aggregation of iron at 25ºC is *solid* while the state of aggregation at 2000ºC is *liquid*.

b. Water has a melting point of 0ºC and a boiling point of 100ºC in normal pressure conditions. The state of aggregation of water at 200ºC is *gas*, at -23ºC is solid and at 25ºC is *liquid*.

c. The boiling point of nitrogen is –196ºC . Its state of aggregation is *liquid* at -200ºC At 20ºC the state of nitrogen is *gas*.

d. Salt has a melting point of 800ºC. At 200ºC the state of aggregation of salt is *solid* and at 1000ºC salt is in *liquid* state.

e. Bromide has a melting point of -7,2ºC. At 30ºC bromide is in *liquid* state.

f. The boiling point of a substance is 78,5º C and the melting point is 2ºC. At 100ºC the substance is in gas state. At 50ºC it is in *liquid* state and at 0ºC it is in *solid* state.

g. The boiling point of a substance is 200º C and the melting point is 23ºC. At 0ºC the substance is in *solid* state. At 100ºC it is in *liquid* state and at 300ºC it is in gas state.

21. Match the states of the matter with the suitable statements :

	Fixed volume	Separated particles
Solid	Determined shape	Particles vibrating around a fixed position
	Can be compressible	Joined particles
	Variable shape	Particles ordered in fix positions
Liquid	High density	Joined but displacing particles
	Low density	Strong attraction forces
	Can flow	Medium attraction forces
Gas	Impossible flowing	Extremely low forces

Solid	Fixed volume	Joined particles	Strong attraction forces
	Determined shape	Particles ordered in fix positions	
	High density	Joined particles	
	Impossible flowing	Joined particles	
Liquid	Fixed volume	Joined particles	Medium attraction forces
	Variable shape	Joined but displacing particles	
	High density	Joined particles	
	Can flow	Joined but displacing particles	
Gas	Can be compressible	Separated particles	Extremely low forces
	Variable shape	Displacing particles	
	Low density	Separated particles	
	Can flow	Displacing particles	

22. Complete the following sentences, keeping in mind exercise 4.

a. Particles in solids are *joined, ordered and vibrating* due to attraction forces are strong. As consequence, properties of solids are: *fixed* shape, *defined* volume and *high* density.

b. Particles in liquids *are joined, disordered and displacing* due to attraction forces are medium. As consequence, properties of liquids are: *non-defined* shape, *defined* volume and *high* density.

c. Particles in gases *are separated, disordered and displacing* due to attraction forces are *extremely weak*. As a consequence, properties of gases are: *non-defined* shape, *non-defined* volume and low density.

d. *Liquids* and *gasses* can flow because their particles *are displacing*.

23. Add the correct Word:

a. A substance changes from liquid to solid state. That change of aggregation is called *solidification*.

b. A substance changes from solid to liquid state. That change of aggregation is called *melting o liquefaction*.

c. A substance changes from liquid to gas state. That change of aggregation is called *vaporization*.

d. A substance changes from gas to liquid state. That change of aggregation is called *condensation*.

e. A substance changes from gas to solid state. That change of aggregation is called *inverse sublimation*.

f. A substance changes from solid to gas state. That change of aggregation is called *sublimation*.

24. Imagine you leave on a table a glass with four ice cubes inside. Describe what would happen over the time. If you put a thermometer inside, can you explain which temperature it would measure during the process?

The temperature of the ice would increase till 0ºC. Then ice melts while temperature remains constant. When all the ice is in liquid state the temperature of water increases till the temperature of the room.

25. You put a little rock inside a graduated cylinder, does it get the shape of the cylinder? Why? If you put 10 mL of alcohol inside the graduated cylinder, does it get the cylinder shape? Can you explain it?

The rock is a solid and it has a fixed shape while the alcohol is a liquid and it gets the cylinder shape because it hasn´t got a defined shape. Particles in the liquid can displace and place in the spaces of the graduated cylinder getting its shape.

4. CONDITIONS OF A MATERIAL SYSTEM. TEMPERATURE AND PRESSURE

Se presentan la temperatura y la presión como propiedades llamadas condiciones. El objetivo de esta pregunta es que los alumnos utilicen la conversión de unidades en estas dos magnitudes.

Se pide la realización de ejercicios sobre conversión de unidades en las magnitudes temperatura y presión.

Practice the concepts with the following exercises:

26. Express in Celsius degrees:

a. 47ºF

$$\frac{ºC}{100} = \frac{ºF - 32}{180}$$

$$\frac{ºC}{100} = \frac{47ºF - 32}{180}$$

$$T(ºC) = \frac{45ºF - 32}{180} \cdot 100 = \mathbf{7,2ºC}$$

b. 312 K

$$\frac{ºC}{100} = \frac{K - 273}{100}$$

$$ºC = K - 273$$

$$T(ºC) = 312K - 273 = \mathbf{39ºC}$$

c. -54ºF

$$\frac{ºC}{100} = \frac{ºF - 32}{180}$$

$$\frac{ºC}{100} = \frac{-54ºF - 32}{180}$$

$$T(ºC) = \frac{-54ºF - 32}{180} \cdot 100 = \mathbf{-47,8ºC}$$

d. 82 K

$$\frac{ºC}{100} = \frac{K - 273}{100}$$

$$ºC = K - 273$$

$$T(ºC) = 82K - 273 = \mathbf{-191ºC}$$

e. 200ºF

$$\frac{ºC}{100}=\frac{ºF-32}{180}$$

$$\frac{ºC}{100}=\frac{200ºF-32}{180}$$

$$T(ºC)=\frac{200ºF-32}{180}\cdot 100=\mathbf{93,3ºC}$$

f. 500 K

$$\frac{ºC}{100}=\frac{K-273}{100}$$

$$ºC=K-273$$

$$T(ºC)=500K-273=\mathbf{227ºC}$$

27. Convert to the International System Unit:

a. 120ºC

$$\frac{ºC}{100}=\frac{K-273}{100}$$

$$120ºC=K-273$$

$$T(K)=120ºC+273=\mathbf{393K}$$

b. 300ºF

$$\frac{K-273}{100}=\frac{ºF-32}{180}$$

$$\frac{K-273}{100}=\frac{300ºF-32}{180}$$

$$T(K)=\frac{300ºF-32}{180}\cdot 100+273=\mathbf{421,9K}$$

c. -12ºF

$$\frac{K-273}{100}=\frac{ºF-32}{180}$$

$$\frac{K-273}{100}=\frac{-12ºF-32}{180}$$

$$T(K)=\frac{-12ºF-32}{180}\cdot 100+273=\mathbf{248,6K}$$

d. -54ºC

$$\frac{ºC}{100}=\frac{K-273}{100}$$

$$-54ºC=K-273$$

$$T(K)=-54ºC+273=\mathbf{219K}$$

28. Make the asked conversions using conversion factors.

a. 3 atm to Pa

$$1\ atm=101300Pa$$

$$3atm.\frac{101300Pa}{1atm}=\mathbf{303900\ Pa}$$

b. 1,2 bar to Pa

$$1bar=10^5Pa$$

$$1{,}2bar.\frac{10^5Pa}{1bar}=\mathbf{1,2\cdot 10^5\ Pa}$$

c. 1,7 atm to mmHg

$$1\ atm=760mmHg$$

$$1{,}7atm.\frac{760\ mmHg}{1atm}=\mathbf{1292\ mmHg}$$

d. 860 mmHg to atm

$$1\ atm=760mmHg$$

$$860\ mmHg.\frac{1atm}{760\ mmHg}=\mathbf{1,13\ atm}$$

5. GAS LAWS

Se presentan las leyes de los gases y su explicación desde la teoría cinético-molecular y se pide la realización de ejercicios básicos de aplicación.

Para la explicación desde el punto de vista de la teoría cinético molecular es muy apropiado el siguiente enlace:

https://phet.colorado.edu/sims/html/gas-properties/latest/gas-properties_all.html?locale=es

Es importante que el profesor siga insistiendo en la organización en el momento de resolver el problema.

Practice the laws with the following exercises:

29. Initially, we have a recipient closed by a piston with a volume of 1 L that is under a pressure of 750 mmHg. If we push he piston so the final volume is 250 mL, what will be the final pressure?

Data

T= constant

V_1= 1 L

P_1=750 mmHg

V_2=250 mL

P_2=?

Solving method

Firstly we have to convert 250 mL to L:

$$250\ mL \cdot \frac{1\ L}{10^3 mL} = 0{,}25\ L$$

Boyle-Mariotte law is needed:

$$P_1 \cdot V_1 = P_2 \cdot V_2$$

$$750\ mmHg \cdot 1L = P_2 \cdot 0{,}25L$$

$$\boldsymbol{P_2 = 3000\ mmHg}$$

30. Now we have the same recipient, closed by a piston, with a volume of 750 mL under a pressure of 1 atm. If we want it to be under a pressure of 1580 mmHg, ¿What will be the final volume?

Data

T= constant

V_1= 750 mL

P_1=1 atm=760 mmHg

V_2=?

P_2=1580 mmHg

Solving method

Boyle-Mariotte law is needed:

$$P_1 \cdot V_1 = P_2 \cdot V_2$$

$$760\ mmHg \cdot 750\ mL = 1580\ mmHg \cdot V_2$$

$$\boldsymbol{V_2 = 360{,}76\ mL}$$

31. There is a balloon in the classroom, with a volume of 1,5 L and at a temperature of 25 ºC. We put it close to the heater and it reaches a temperature of 50ºC. Which will be the final volume?

Data

T_1= 25ºC

V_1= 1,5 L

T_2=50ºC

V_2=?

Solving method

Firstly you need to express temperatures in Kelvin

$$ºC = K - 273$$

T_1(K)=298K

T_2(K)=323K

Then, you have to use the adequate gas law:

$$\frac{V}{T} = k$$

Which is the same as:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{1{,}5\ L}{298K} = \frac{V_2}{323K}$$

$$V_2 = \frac{1{,}5\ L}{298K}.323K = \boldsymbol{1{,}6\ L}$$

32. The same balloon, with a volume of 1,5 L and at a temperature of 25ºC is now put on the fridge, and at the end of the experiment has a volume of 600 mL. Which is the temperature inside the balloon?

Data

T_1= 25ºC=298K

V_1= 1,5 L

T_2=50ºC

V_2=600 mL=0,6L

Solving method

You have to use the adequate gas law:

$$\frac{V}{T} = k$$

Which is the same as:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{1{,}5\ L}{298K} = \frac{0{,}6L}{T_2}$$

$$\boldsymbol{T_2} = \frac{298K}{1{,}5\ L}.0{,}6L = \boldsymbol{119{,}2K}$$

33. A spray deodorant has a pressure inside of 1520 mmHg at a temperature of 20ºC. If it is heated until it reaches a temperature of 100 ºC, what will be the final pressure inside the spray? We know that a spray explodes when it is a pressure inside bigger than 8 amt. Will this spray explode?

Data

T_1= 20ºC=293K

P_1= 1520 mmHg

T_2=100ºC=373K

P_2=?

Solving method

You have to use the adequate gas law:

$$\frac{P}{T} = k$$

Which is the same as:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{1520\ mmHg}{293K} = \frac{P_2}{373K}$$

$$\boldsymbol{P_2} = \frac{1520\ mmHg}{293K}.373K = \boldsymbol{1935\ mmHg}$$

That in atmospheres it is expressed as:

$$1935\ mmHg \cdot \frac{1\ atm}{760\ mmHg} = 2{,}55\ atm$$

It won´t explode because pressure is smaller than 8 atm.

34. We have a recipient of 5 L under a pressure of 3 atm and at a temperature of 300K. If we keep the volume constant, what will be the final temperature if the final pressure is 1 atm?

Data

T_1= 300 K

P_1= 3 atm

Solving method

You have to use the adequate gas law:

$$\frac{P}{T} = k$$

T_2=?

P_2=1 atm

Which is the same as:

$$\frac{P_1}{T_1}=\frac{P_2}{T_2}$$

$$\frac{3\ atm}{300K}=\frac{1\ atm}{T_2}$$

$$\boldsymbol{T_2}=\frac{1atm}{3\ atm}.300K=\mathbf{100\ K}$$

35. There is a recipient of 3 dm3 under a pressure of 1200 mmHg and at a temperature of 20º C. If the final volume is 5 L and the final pressure is 3 atm, what will be the final temperature?

Data

V_1=3 L

T_1= 20ºC=293K

P_1= 1200 mmHg

V_2= 5L

P_2=3 atm

T_2=?

Solving method

Firstly, pressure values have to be expressed in the same units:

$$3\ atm\cdot\frac{760\ mmHg}{1\ atm}=2280\ mmHg$$

Then, you have to use the adequate gas law:

$$\frac{P\cdot V}{T}=k$$

Which is the same as:

$$\frac{P_1\cdot V_1}{T_1}=\frac{P_2\cdot V_2}{T_2}$$

$$\frac{1200\ mmHg\cdot 3L}{293K}=\frac{2280\ mmHg\cdot 5L}{T_2}$$

$$\boldsymbol{T_2}=\frac{2280\ mmHg\cdot 5L}{1200\ mmHg\cdot 3L}.293K=\mathbf{927,8K}$$

6. LEARNING SITUATION: MEASURING THE DENSITY OF A SUBSTANCE

Esta situación de aprendizaje tiene unos objetivos claros:

- Se revisan y aplican las etapas del método científico. El alumno debe hacerse una pregunta a partir de la que se planificará la experimentación.
- Se insiste en la densidad como propiedad específica de la materia. Debemos utilizar cuerpos hechos de la misma sustancia y calculamos la densidad de la sustancia.
- Está diseñada para que los alumnos aprendan a manejar una balanza para medir masa de sólidos y a determinar volumen de piezas por alguno de los dos métodos diferentes: de forma directa sumergiéndolas en agua en el interior de una probeta o bien midiendo sus dimensiones con un calibre y utilizando las ecuaciones de volumen. Para el cálculo de la densidad se utiliza el valor medio de los volúmenes obtenidos por ambos métodos.

Se comienza la situación de aprendizaje explicando el objetivo y pidiendo a los alumnos que en parejas o grupos de tres piensen de qué sustancia quieren medir la densidad, que busquen posibilidades entre los objetos que le rodean y que es necesario que cuenten con varios cuerpos que estén hechos de la misma sustancia. Se da un plazo para que alumnos elaboren los grupos y los cuerpos y transmitan al profesor/a estos datos.

Con las propuestas se les pide que hagan su planificación: instrumentos de medida que van a utilizar. El profesor/a prepara el material de laboratorio para la experimentación.

Se les entrega una ficha para que rellenen durante la experimentación y entreguen para su corrección.

DATA MEASURING THE DENSITY OF......................

....

NAMES ....

....

PIECE	MASS (g)	VOLUME (cm3)	DENSITY (g/cm3)

Una vez analizados los datos, se les pide que elaboren una presentación en la que se muestre cómo han seguido las etapas del método científico, sus datos y su análisis y conclusiones.

El/la profesor/a debe hacer de guía en todo momento. Cada experimentación tiene un carácter diferente; en unos casos es buscar cuál puede ser el material, en otros casos se descubre que los materiales son diferentes, en otros resulta que algunas de las piezas son huecas en su interior dando datos inesperados, etc.

Finalmente se realiza el "Density conference" en la que cada grupo presenta su trabajo a los demás.

Respecto a las ideas, se debe tener paciencia porque siempre surgen: cubiertos, dados de diferente tamaño, canicas, piezas de algún juego, etc. y de ese modo llevamos un contenido con los objetos que rodean al alumno y acercamos la ciencia y el aprendizaje a la vida diaria.

Con esta situación de aprendizaje se valora la elaboración de contenidos y la comunicación oral.

7. LEARNING SITUATION. TICKTOCKER LABORATORY: AN EASY WAY TO OBSERVE GAS LAWS

Esta situación de aprendizaje tiene como objetivos:

- Que los alumnos comprendan mejor el comportamiento y leyes de los gases.
- Que elaboren un contenido en video a modo de experimento. Se trabaja de esta manera la competencia digital, ya que el vídeo debe estar editado.
- Que comprendan el fenómeno a grabar y lo relacionen con el comportamiento de los gases y las leyes estudiadas.

Otras dos posibles propuestas son:

MATERIAL: BOTTLE, FUNNEL, PLASTICINE and WATER.

EXPERIMENTAL WORK:

1. Do the assembly shown on the photograph.
2. Be sure that the plasticine completely closes the mouth of the bottle.
3. Try to drop water to the bottle through the funnel. What happens?
4. Try to explain the occurrence taking in mind the Kinetic-Molecular Theory.

MATERIAL: Two pens and two balloons

EXPERIMENTAL WORK:

1. Construct the assembly shown on the photograph. Be sure that the assembly is balanced. Write a mark in the middle of the assembly.
2. Construct it again but now with a blown up balloon at one end. Is the pen supported on the same point?
3. Poke the blown balloon now. What happens?
4. Try to explain why that happens.

8. VOCABULARY REVIEW

Se presenta un cuadro con los conceptos vistos en el tema organizados de forma lógica.

En tres columnas de diferente color se presentan los estados de la materia con el vocabulario correspondiente, entre ellas, los cambios de estado. Junto a los sólidos los nombres de las tres formas más características de sólidos geométricos y junto a los gases el vocabulario relacionado con las leyes de los gases.

Finalmente, en la primera fila de la tabla el vocabulario general del tema.

9. READING COMPREHENSION: WATER VAPOUR AND METEOROLOGY

La lectura trata de hacer ver al alumno el motivo de la formación de estelas de condensación en los aviones así como de su permanencia en la atmósfera.

After reading the text, answer the next questions:

1. Why is it so important to drink water every day? Do you know how many glasses of water are recommended?

It is very important the body keeps hydrated because a 70% is made of water.

We need to drink two litres of water a day. If a glass contains 200 mL, we need to drink around ten glasses of water a day.

2. Where does the vapour water in the air come from?

Vapour water in the atmosphere comes from evaporation of water in oceans, lakes, rivers and so on.

3. Why do you think there is few vapour water in deserts?

Because there are not rivers, lakes or oceans in deserts.

4. What is the dew? Where it comes from?

Water vapour in the atmosphere condensates on surfaces when temperature descends, during the night.

5. What is the difference between hoarfrost and rime frost?

Rime frost is produced in foggy nights of winter, when ice spiky formations are formed on cool surfaces, while hoarfrost is composed of tiny ice crystals produced in clear nights when temperature drops below cero and dew freezes.

6. What is a contrail? How is it formed?

Water vapour in gases expelled by planes condensates when they get in contact with the cold air of the atmosphere. Contrail means condensed trail.

7. How this can be used to predict weather?

Contrails indicate the atmosphere has got humidity while no contrails indicate that the atmosphere is dry.

10. FINAL ACTIVITIES

36. Explain, using the Kinetic Theory, what is pressure and what is temperature. What happens to pressure if temperature increases? Why?

Pressure is the frequency of particle collisions.

If temperature increases, velocity of particles increases, and frequency of collisions will be higher. Consequently, pressure increases too.

37. The density of certain substance is 0,88 g/cm³. Calculate the mass of that substance that fits in a flask of 100 mL.

Data	Solving method
m= ?	$D = \frac{m}{V}$
V= 100 mL= 100 cm³	$0{,}88\ {}^{g}/_{cm^3} = \frac{m}{100\ cm^3}$
D= 0,88 g/cm³	$m = 100\ cm^3 \cdot 0{,}88\ {}^{g}/_{cm^3} = \mathbf{88\ g}$

38. The density of air is 1,18 Kg/m³- Calculate the mass of air that there is in a room with the following dimensions: 5m x 3 m x 2 m.

Data	Solving method
m= ?	$D = \frac{m}{V}$
V= 5 m·3 m·2 m	$1{,}18\ {}^{kg}/_{m^3} = \frac{m}{30\ m^3}$
V=30 m³	$m = 30\ m^3 \cdot 1{,}18\ {}^{kg}/_{m^3} = \mathbf{35{,}4\ kg}$
D= 1,18 kg/m³	

39. We put a piece of certain metal inside a graduated cylinder and it displaces a volume of 20 mL. If it has a mass of 54 g, what will be its density? Check in the table 2.A, what is that material?

Data	Solving method
m= 54 g	$D = \frac{m}{V}$
V= 20 mL= 20 cm³	$D = \frac{54\ g}{20\ cm^3} = 2{,}7\ {}^{g}/_{cm^3}$
D= ?	The piece is made up of aluminium

40. We have a gold ingot and we want to know if it is real. To check it we measure its dimensions (30 cm X 10 cm x 3 cm) and we weigh it (17,37 kg.) Calculate its density and decide, looking to table 2.A, if it is real gold or not.

Data	Solving method
m= 17,37 kg =17370 g	$D = \frac{m}{V}$
V= 30cm·10cm·3 cm	
V=900 cm³	$D = \frac{17370\ g}{900\ m^3} = \mathbf{19{,}3\ {}^{g}/_{cm^3}}$
D=?	**It is real gold**

41. If a piece of silver has a volume of 20 mL. What will be its mass? (Take the density of silver from table 2.A).

Data	Solving method
m= ?	$D = \frac{m}{V}$
V=20 mL=20 cm³	$10{,}40\ {}^{g}/_{cm^3} = \frac{m}{20\ cm^3}$
D= 10,40 g/cm³	$m = 20\ cm^3 \cdot 10{,}40\ {}^{g}/_{cm^3} = \mathbf{208\ g}$

42. The volume of certain gas at 20ºC and 5 atm is 50 L. What volume will occupy at 1 atm if we keep the temperature constant?

Data	Solving method
V_0=50L	Temperature remains constant, so Boyle-Mariotte law has to be used:
P_0=5atm	$P_0 \cdot V_0 = P \cdot V$

Data	Solving method
T_0=20ºC	$5\ atm \cdot 50L = 1\ atm \cdot V$
T=20ºC	$\boldsymbol{V = 250L}$
P=1 atm	
V=?	

43. At what temperature is it necessary to heat 3 L of air to double its volume if the pressure is constant and the initial temperature is 0ºC?

Data	Solving method
V_0=3L	Pressure remains constant, so Gay-Lussac law has to be used:
T_0=0ºC	$\frac{V_0}{T_0} = \frac{V}{T}$
T=?	$\frac{3\ L}{273\ K} = \frac{6\ L}{T}$
V=6 L	$\boldsymbol{T = 546K}$
	$546\ K = 273 + T(ºC)$
	$\boldsymbol{T = 273ºC}$

44. Certain gas occupies 10 L at 2 atm and 0ºC. At what pressure will occupy a volume of 10 L if the temperature doesn't change? Write the result in mmHg.

Data	Solving method
V_0=10L	Temperature remains constant, so Boyle-Mariotte law has to be used:
P_0=2 atm	$P_0 \cdot V_0 = P \cdot V$
T_0=0ºC	$2\ atm \cdot 10L = P \cdot 10L$
T=0ºC	$P = 2\ atm \frac{760\ mmHg}{1\ atm} = \boldsymbol{1520\ mmHg}$
P=?	
V=10L	

45. There is a gas inside a recipient that occupies a volume of 2 L at 20ºC and 5 atm. What pressure there will be in the recipient if the final volume is 1 L and the temperature 50ºC?

Data	Solving method
V_0=2L	Firstly we need to express temperatures in K:
T_0=20ºC	$T_0(K) = 273 + 20ºC = 293K$
P0=5 atm	$T(K) = 273 + 50ºC = 323K$
T=50ºC	$\frac{P_0 \cdot V_0}{T_0} = \frac{P \cdot V}{T}$
V=1 L	$\frac{5\ atm \cdot 2\ L}{293\ K} = \frac{P \cdot 1L}{323\ K}$
P=?	$\boldsymbol{P = 11\ atm}$

46. A piece of glass has a mass of 24 kg. Which volume does it occupy? Express in cm³.

Data	Solving method
m= 24 kg=24000 g	$D = \frac{m}{V}$
V= ?	$2{,}6\ {}^{g}/_{cm^3} = \frac{24000\ g}{V}$
D= 2,6 g/cm³	$V = \frac{24000\ g}{2{,}6\ {}^{g}/_{cm^3}} = \boldsymbol{9230,76\ cm^3}$

47. Does always 1 kg of iron occupy the same volume? And 1 kg of oil? And 1 kg of air? Explain the answers taking in mind the Kinetic-Molecular Theory

All the substances, in solid, liquid or gas state, dilate when are heated. But a constant temperature iron and oil occupy the same volume. The air volume depends on pressure too.

48. A cylinder made of silver has a radius of 2 m and a high of 4,5 m .Calculate its mass in g.

Data	Solving method
m= ?	Firstly, we have to calculate the volume of the cylinder:
R=2 m	$V = \pi \cdot r^2 \cdot H$
H=4,5 m	$V = \pi \cdot (2m)^2 \cdot 4{,}5m = 56{,}5m^3$
D= 10,4 g/cm³	Then, we need to express density in the IS unit:
	$10{,}4\ {}^{g}/_{cm^3} \cdot \frac{1\ kg}{10^3 g} \cdot \frac{10^6 cm^3}{1m^3} = 10400\ {}^{kg}/_{m^3}$
	Finally, we use the density equation:
	$D = \frac{m}{V}$
	$10400\ {}^{kg}/_{m^3} = \frac{m}{56{,}5m^3}$
	$m = 10400\ {}^{kg}/_{m^3} \cdot 56{,}5m^3 = 587600\ kg$

49. Calculate your volume using data from table of densities.

Supposing a mass of 50 kg:

Data	Solving method
m= 50 kg=50000 g	$D = \frac{m}{V}$
V= ?	$0{,}995\ {}^{g}/_{cm^3} = \frac{50000\ g}{V}$
D= 0,995 g/cm³	$V = \frac{50000\ g}{0{,}995\ {}^{g}/_{cm^3}} = \boldsymbol{50251,3\ cm^3}$
	We can express the volume in litres
	$50251{,}3\ cm^3 \cdot \frac{1\ L}{10^3 cm^3} = \boldsymbol{50,25\ L}$

50. Under a pressure of 1 atm an ideal gas occupies a volume of 3L. Which volume would it have under a pressure of 3 atm if the temperature remains unchanged?

Data	Solving method
V_0=3L	Temperature remains constant, so Boyle-Mariotte law has to be used:
P_0=1 atm	$P_0 \cdot V_0 = P \cdot V$
P=3 atm	$1\ atm \cdot 3L = 3\ atm \cdot V$
V=?	$\boldsymbol{V = 1\ L}$

How much have you learnt?

51. The boiling point of a substance is 90ºC and the melting point is 10ºC.

At 100ºC the substance is in gas state and its particles are separated and freely moving.

At 50ºC the substance is in liquid state and its particles are joined, disordered and displacing.

At 0ºC the substance is in solid state and its particles are joined, ordered and vibrating.

52. Explain how you can measure the mass and volume of an irregular solid. ¿How can you calculate its density?

I can measure the mass using a balance and the volume, using a graduated cylinder. The solid, once immersed in water, displaces water. The volume of water displaces corresponds to the volume of the solid.

After knowing the mass and volume of the solid, density is calculated as: $D = \frac{m}{V}$

53. Calculate the volume of the following pieces:

a. a cube with an edge of 2 cm

$$V = L^3 = (2\ cm)^3 = \mathbf{8cm^3}$$

b. an sphere with a radio of 2 cm

$$V = \frac{4}{3}\pi R^3 = \frac{4}{3}\pi(2\ cm)^3 = \mathbf{33,5\ cm^3}$$

54. If the solids in 2 are made of nickel, calculate their mass.

Cube Data	Solving method
m= ?	$D = \frac{m}{V}$
V=8 cm³	$8{,}80\ ^{g}/_{cm^3} = \frac{m}{8\ cm^3}$
D= 8,80 g/cm³	$m = 8\ cm^3 \cdot 8{,}80\ ^{g}/_{cm^3} = \mathbf{70,4\ g}$

Sphere Data	Solving method
m= ?	$D = \frac{m}{V}$
V=33,5 cm³	$8{,}80\ ^{g}/_{cm^3} = \frac{m}{33{,}5\ cm^3}$
D= 8,80 g/cm³	$m = 33{,}5\ cm^3 \cdot 8{,}80\ ^{g}/_{cm^3} = \mathbf{294,8\ g}$

55. Complete the following sentences:

a. Specific properties of a material system depend on *the substance* they are made of.

b. Changing of state of aggregation is a physical process consisting in *changes in the internal structure of the matter due to the strengthening or weakening of attraction forces among particles.*

c. Changing from liquid to gas is called *vaporization*. This process takes place in two different ways: *evaporation* and *boiling*.

56. Camphor balls are used to avoid the presence of moths. Which change of state takes place when they are in contact with the air?

Sublimation, because they change directly from solid state to gas state.

57. Explain how you can directly measure the volume of an irregular object. How can you measure its mass? How can you calculate its density?

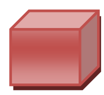
I can measure the volume using a graduated cylinder. I fill the graduated cylinder with water till a level and when I submerge the body in the water the level rises just the volume of the body. I can calculate its volume subtracting the final level and the initial level.

I can measure its mass using a balance, simply holding the body on the balance once calibrated.

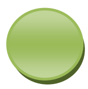
I can calculate the density dividing the mass into the volume.

58. How can you calculate the volume of a cubic object with an edge of a m? How can you calculate the volume of an spherical object with a radius of r m?

I can calculate the cube volume: $\boldsymbol{V = m \cdot m \cdot m = m^3}$



I can calculate the sphere volume: $\boldsymbol{V = \frac{4}{3}\pi \cdot m^3}$



59. Why solids expand while heating? Does this process happen to liquids and gases too? Take in mind the Kinetic-Molecular Theory.

When a body is heated its molecules start to move more quickly. As a consequence, molecules separate among them and the body expands. It is a process that happens in gas, liquid and gas bodies.

60. Three quarters of a liter of a liquid have 600 g of mass. Calculate the density of the liquid in g/cm³ and kg/m³.

Data	**Solving method**
m= 600 g	$D = \frac{m}{V}$
V= ¾ L= 750 cm³	$D = \frac{600\ g}{750\ cm^3} = \mathbf{0,8}\ {}^{\boldsymbol{g}}/_{\boldsymbol{cm^3}}$
D= ?	$D = \frac{0{,}8\ g}{1\ cm^3} \cdot \frac{1\ kg}{1000\ g} \cdot \frac{10^6 cm^3}{1\ m^3} = \mathbf{800}\ {}^{\boldsymbol{kg}}/_{\boldsymbol{m^3}}$

61. When we heat 25 cm³ of a gas contained in a balloon from 25ºC to 80ºC the volume of the gas reached .... cm³.

Data	**Solving method**
T_0=20ºC	Firstly we need to express temperatures in K:
V_0=25 cm³	$T_0(K) = 273 + 25ºC = 298K$
T=80ºC	$T(K) = 273 + 80ºC = 353K$
V=?	$\frac{V_0}{T_0} = \frac{V}{T}$
	$\frac{25\ cm^3}{298\ K} = \frac{V}{353\ K}$
	$\boldsymbol{V = 29,6\ cm^3}$

UNIT 3. PURE SUBSTANCES AND MIXTURES. ELEMENTS AND COMPOUNDS

1. PURE SUBSTANCES AND MIXTURES

Se presenta la clasificación de los sistemas materiales en sustancias puras y mezclas en un cuadro comparativo de propiedades, acompañado de la representación de partículas que ayuda a la comprensión de los conceptos.

A continuación, se clasifican las mezclas en homogéneas y heterogéneas y se presenta la representación de ambas, del mismo modo.

Finalmente se define elemento y compuesto como tipos de sustancias puras. Se informa a los alumnos que los elementos son las sustancias puras que se encuentran en la tabla periódica y se les anima a que tengan un primer contacto con ella y ante la duda en los ejercicios busquen en la tabla periódica si el nombre del sistema material se encuentra en ella.

Se plantean ejercicios sobre diferenciación entre sustancias puras y mezclas, elementos y compuestos, mezclas homogéneas y heterogéneas.

Practice these concepts answering the following exercises:

1. Classify the following substances in mixtures (homogeneous or heterogeneous) or pure substances (element or compound):

Pure substance		Mixture	
Element	Compound	Homogeneous	Heterogeneous
Oxygen Copper	Sodium chloride Distilled water	Bronce (copper and tin) Water you drink Salty water	Sand Water of the river Orange juice

2. Complete the sentences:

a. A pure substance is a sort of material system which:

i. Cannot be separated into several substances by physical processes

ii. Has a constant and uniform composition

iii. Has got constant specific properties

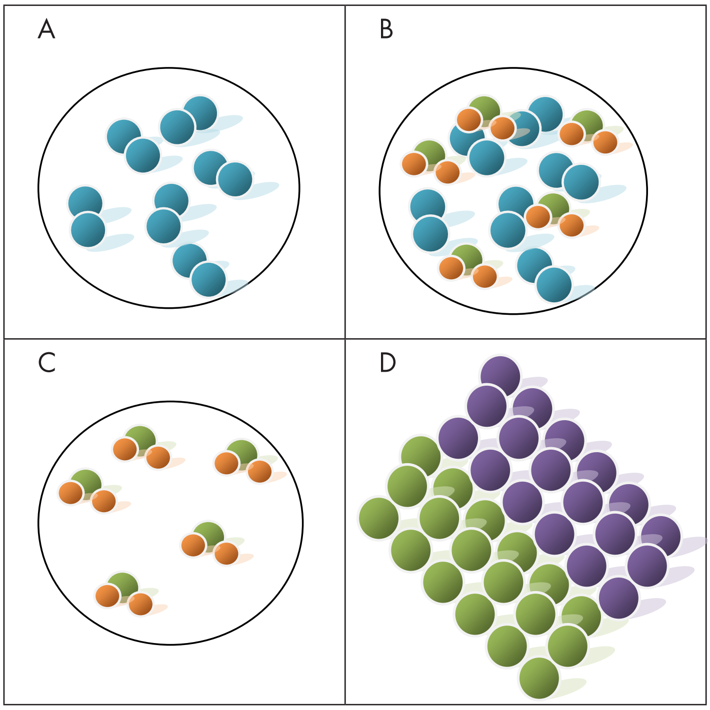
b. An element is a sort of *pure substance* which *is made up of the same type of atoms.*

c. A compound is a sort of *pure substance* which *is made up of atoms of two or more different elements.*

d. A mixture is a sort of *material system* which *can be separated into two or more substances by physical means.*

e. A mixture can be *homogeneous* and *heterogeneous.*

3. Look at the drawings and classify as homogeneous mixture, heterogeneous mixture, element or compound:



A. Pure substance. Element

B. Homogeneous mixture

C. Pure substance. Compound

D. Heterogeneous mixture

2. SOLUTIONS: CONCENTRATION OF A CHEMICAL SOLUTION

Se presenta la disolución como mezcla homogénea y se resumen en un cuadro los tipos de disoluciones. Lo más importante de este punto es la definición de concentración y su expresión en g/L, % masa y % volumen.

El alumno debe conocer cómo enfrentarse a problemas de los tres tipos de concentración. Para ello se presentan tres ejemplos diferentes.

Se plantea la resolución de ejercicios sobre concentración de disoluciones.

Practice the concept concentration of a solution solving the following problems:

4. Which is the concentration of a solution prepared when 3 g of sugar is added to 200 g of water?

Data

Solute (Sugar) 3 g

Solvent (water) 200 g

Solution (sugar + water) 203 g

Concentration?

Solving method

All data have been done in mass so we only can use concentration in %mass

$$\%mass = \frac{solute(g)}{solution(g)}.100$$

$$\%mass = \frac{3g}{203g}.100 = 1{,}5\%mass$$

5. Imagine you mix 35 ml of alcohol with 250 ml of water. Which is the concentration of the solution?

Data

Solute (alcohol) 35 mL

Solvent (water) 250 mL

Solution (alcohol + water) 285 mL

Concentration?

Solving method

All data have been done in volume (L) so we only can use concentration in %volume

$$\%volume = \frac{solute(mL)}{solution(mL)}.100$$

$$\%volume = \frac{35mL}{285mL}.100 = 12{,}3\%volume$$

6. Calculate the concentration of a solution prepared when 5 g of salt is added to 200 ml of water.

Data

Solute (Salt) 5 g

Solvent (water) 200 mL

Solution (sugar + water)

Concentration?

Solving method

Solvent is water whose density is 1g/mL. For that reason, the mass of solvent is 200 g.

Now, all data is in mass so we only can use concentration in %mass

$$\%mass = \frac{solute(g)}{solution(g)}.100$$

$$\%mass = \frac{5g}{205g}.100 = 2{,}44\%mass$$

7. An amalgam has 300 g of gold and 3 g of mercury. Calculate its concentration.

Data

Solute (mercury) 3 g

Solvent (gold) 300 g

Solution (amalgam) 303 g

Concentration?

Solving method

All data have been done in mass so we only can use concentration in %mass

$$\%mass = \frac{solute(g)}{solution(g)}.100$$

$$\%mass = \frac{3g}{303g}.100 = 0{,}99\%mass$$

8. Calculate the concentration of the solution, in mass percentage, prepared by adding 25 g of sugar to a bottle of water with a volume of 750 cm^3.

Data

Solute (Sugar) 25 g

Solvent (water) 750 cm^3

Solution (sugar + water)

Concentration?

Solving method

Solvent is water whose density is 1g/cm^3. For that reason, the mass of solvent is 750 g.

Now , all data are expressed in mass, so we only can use concentration in %mass

$$\%mass = \frac{solute(g)}{solution(g)}.100$$

$$\%mass = \frac{25g}{775g}.100 = 3{,}2\%mass$$

9. You must prepare 300 mL of a solution of Sodium hydroxide (NaOH) in water with a concentration of 10 g/L . Which mass of Sodium hydroxide do you need?

Data

Solute (NaOH)?

Solvent (water)

Solution (sugar + water) 300 mL

Concentration 10 g/L

Solving method

Concentration is expressed in g/L so: firstly, we need to express volume of solution in L

$$300\ mL.\frac{1\ L}{10^3\ mL} = 0{,}3\ L$$

$$C(g/L) = \frac{solute(g)}{solution(L)}.100$$

$$10g/L = \frac{solute(g)}{0{,}3L}$$

$$solute(g) = 10\,{}^{g}/_{L}.0{,}3L$$

$$\boldsymbol{solute(g) = 3\ g\ of\ NaOH}$$

10. In a bottle of 750 cm³ of wine you read that the concentration of alcohol is 11% in volume. How much alcohol is there in the bottle?

Data	**Solving method**
Solute (alcohol) ?	As concentration in % vol in known, we will use the equation:
Solvent (water)	$\%vol = \frac{solute\ (cm^3)}{solution\ (cm^3)} \cdot 100$
Solution (wine) 750 cm³	$11\% = \frac{solute\ (cm^3)}{750\ cm^3} \cdot 100$
Concentration 11% vol	$\%\ \boldsymbol{alcohol} = \mathbf{82,5\ cm^3}$

11. You have 500 g of bronze with a concentration of copper of 25% in mass. Which is the mass of copper and tin in the amalgam?

Data	**Solving method**
Solute (copper) ?	As concentration in % vol in known, we will use the equation:
Solvent (tin) ?	$\%mass = \frac{solute\ (cm^3)}{solution\ (cm^3)} \cdot 100$
Solution (wine) 500 g	$25\% = \frac{copper\ (g)}{500\ g} \cdot 100$
Copper concentration 25% mass	$\boldsymbol{Mass\ copper} = \mathbf{125g}$
	$\boldsymbol{Mass\ tin} = 500g - 125g = \mathbf{375g}$

12. A sample of 200 g of platinum has adsorbed 3 g of hydrogen. Calculate the concentration of hydrogen in the sample.

Data	**Solving method**
Solute (hydrogen) 3 g	All data have been done in mass so we only can use concentration in %mass
Solvent (platinum) 200 g	$\%mass = \frac{solute(g)}{solution(g)}.100$
Solution (amalgam) 203 g	$\%mass = \frac{3g}{203g}.100 = 1{,}5\%mass$
Concentration?	

13. The concentration of oxygen in the air is 21% in volume. Calculate the volume of oxygen in a room which volume is 80 m³.

Data	**Solving method**
olute (oxygen) ?	As concentration in % vol in known, we will use the equation:
olvent (nitrogen)	$\%vol = \frac{solute\ (cm^3)}{solution\ (cm^3)} \cdot 100$
olution (air) 8 m³	$21\% = \frac{solute\ (m^3)}{8\ m^3} \cdot 100$
oncentration 21% vol	$\%\ \boldsymbol{oxygen} = \mathbf{1,68\ m^3}$

3. SEPARATION OF MIXTURES

Se resumen en una tabla los métodos de separación. Queda a criterio del profesor el profundizar más o menos en la información.

Nuestra propuesta es que los alumnos aprendan practicando en el laboratorio. Se presentan prácticas experimentales sobre los métodos de separación más importantes.

4. LEARNING SITUATION: SEPARATION OF MIXTURES.

Sin lugar a duda, el alumno aprende a separar mezclas, separando. Por ello se proponen algunas prácticas sencillas para realizar en parejas. Están pensadas también para poder desarrollar a modo de prácticas de cátedra.

La primera práctica es muy apropiada para que los alumnos trabajen distintos métodos de separación de mezclas de sólidos.

La segunda práctica, la destilación, es más apropiada para trabajar en gran grupo. El profesor prepara el montaje de destilación con ayuda de los alumnos y alumnas, se pone el proceso en marcha y se va explicando el proceso, se les hace observar detalles como el aumento de temperatura, el comienzo de la ebullición, la aparición de vapor, la condensación del líquido, el goteo del destilado, etc.

Las otras dos prácticas, la decantación y la solubilidad, son sencillas para hacer en parejas, siempre que se cuente con material, o en gran grupo, en caso contrario.

De este modo, se pueden mostrar otros métodos de separación como la sublimación o la cromatografía en papel.

Se puede comenzar la práctica de decantación mostrando la separación de yodo y sal por sublimación, en una cápsula de porcelana tapada con un embudo invertido. A continuación, se disuelve el yodo de las paredes del embudo en éter, que queda coloreado de violeta y se comienza el desarrollo de la práctica de decantación.

5. LABORATORY ACTIVITY: WORKING WITH SOLUTIONS.

Tras trabajar los conceptos de disolución y concentración, así como haber resuelto problemas variados, es muy interesante que el alumno trabaje en la preparación de disoluciones con el fin de afianzar sus conocimientos. Estas dos prácticas sencillas cumplen ese objetivo.

6. READING COMPREHENSION. THE THREE R´S: "REDUCE, REUSE AND RECYCLE" WASTE HIERARCHY

Una buena manera de introducir el trabajo de ODS en esta unidad es trabajar la regla de las tres R, reducir, reutilizar y reciclar, para educar a nuestros alumnos y alumnas en sostenibilidad.

Se propone una actividad oral de reflexión de buenas costumbres sostenibles tanto en el hogar como en el instituto, tanto en reducir, como reutilizar y en la separación de residuos.

7. VOCABULARY REVIEW

Se muestra un resumen de los diferentes métodos de separación y el vocabulario relacionado con cada uno. De nuevo, los colores diferencian unas columnas de otras y se relacionan con el tipo de mezcla que el método separa.

8. FINAL ACTIVITIES

14. List the differences between a pure substance and a mixture

De nuevo este ejercicio nos permite utilizar "while" como comparativo.

A pure substance cannot be separated into several substances by physical means while a mixture can.

A pure substance has a constant composition while the composition of a mixture can be varied by changing the proportion of substances making it up.

The specific properties of a pure substance are constant while a mixture shows variable specific properties.

15. Classify the following chemical systems into heterogeneous mixture, homogeneous mixture or pure substance:

Pure substance		Mixture	
Element	Compound	Homogeneous	Heterogeneous
nitrogen	water	Water and salt Alloy of copper and nickel Wine Air Bronce	Smoke milk

16. In the kitchen you have the following ingredients: flour, sugar, olive oil, whipped eggs, vinegar, sunflower oil and water. Explain how will you prepare:

- A heterogeneous mixture of two solids.

  Flour and sugar

- A heterogeneous mixture of two liquids.

  Olive oil and water /sunflower oil and water

- A solution of a solid into a liquid.

  Salt and water

- A solution of one liquid into another

  Sunflower oil and olive oil

17. Explain which methods would you use to separate:

a. Salt and rice

- *Visual sorting*
- *Solubility: Salt is soluble in water but rice isn´t. After pouring water to the mixture and stirring it, we can filter the mixture. Rice stays on the filter while salt passes through the filter, once solved in water.*

b. Oil and vinegar

- *It is a mixture of two no miscible substances that can be separated by decantation, using a separating funnel.*

c. Vinegar and water

- *It is a mixture of two miscible liquids. Probably we can separate vinegar by distillation.*

d. Iodine, plaster and iron filings

- *It is a mixture of three solids. Firstly, we can separate iron filling by a magnetic field, using a magnet. Then, heating the mixture of plaster and iodine, iodine can be sublimated while plaster remains in solid state.*

e. Oil, water and salt

- *Salt is soluble in water but it is no soluble in oil. By decantation we can separate oil from the mixture of salt and water. For that process a separating funnel is used. Then, salt is separated from water by evaporation of water.*

18. A solution is prepared mixing of 40 mL of alcohol with water till filling a volume of 800 ml. Express the concentration of the solution in volume percentage

Data	Solving method
Solute (alcohol) 40 mL	$\%vol = \frac{solute\ (cm^3)}{solution\ (cm^3)} \cdot 100$
Solvent (water)	
Solution (water+alcohol) 800 mL	$\%vol = \frac{40\ mL}{800\ mL} \cdot 100 = \mathbf{5\%\ vol}$
Concentration (% vol)?	

19. A solution is prepared solving 30 g of salt in 400 mL of water. Calculate the concentration in Mass percentage.

Data	Solving method
Solute (salt) 30g	Solvent is water whose density is 1g/mL. For that reason, the mass of solvent is 400 g.
Solvent (water) 400mL	
Solution (water+salt)	$\%mass = \frac{solute\ (g)}{solution\ (g)} \cdot 100$
Concentration (% mass)?	$\%mass = \frac{30\ g}{430\ g} \cdot 100 = \mathbf{6,98\%\ mass}$

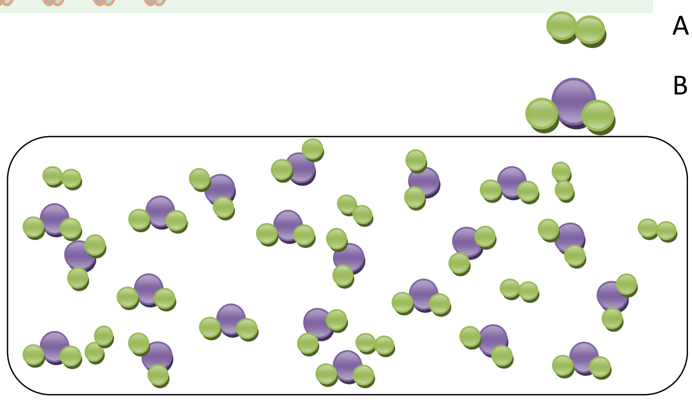
20. A solution has a concentration of 250 g/L of salt in water. Calculate the mass of salt which contains a glass of 200 cm³.

Data	Solving method
Solute (salt)?	Concentration is expressed in g/L so: firstly, we need to express volume of solution in L
Solvent (water)	$200\ cm^3 . \frac{1\ L}{10^3 cm^3} = 0{,}2\ L$
Solution (salt + water) 200 cm³	$C(g/L) = \frac{solute(g)}{solution(L)} .100$
Concentration 250 g/L	$250\ g/L = \frac{solute(g)}{0{,}2L}$
	$solute(g) = 250\ {}^{g}/_{L} . 0{,}2L$
	$\mathbf{solute(g) = 50\ g\ of\ salt}$

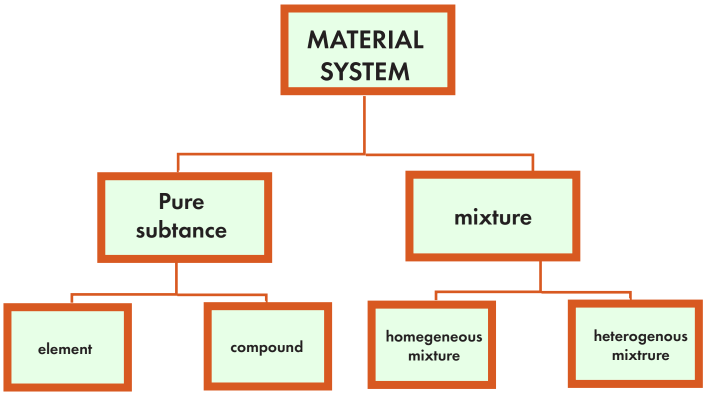
21. Complete using the words of the chart below:

Pure substance	*solution*	*components*	*homogeneous mixture*	
heterogeneous mixture	*solvent*	*solute*	*element*	*compound*

The picture below represents a *homogeneous mixture*, also known as solution. It is composed by two *components*. A represents an *element* and could be considered as a *solute*. B represents a compound and could be considered as a *solvent*.



22. Complete:



23. Decide if the sentences about a solution whose concentration is 300 g/L are true or false:

a. A litre of solution has a mass of 300 g

b. There are 300 mg of water in 1 mL of solution

c. There are 300 mg of solute in 1 mL of solution

d. There are a litre of water in a litre of solution

300g/L means that there are 300g of solute in 1 L of solution so there are 300 mg of solute in 1 mL of solution. So, only c) is true.

24. To prepare a soup 16 g. of salt must be added to 2 L of water.

a. What's the concentration (in g/L) of salt in the soup?

Data	Solving method
Solute (salt) 16 g	To solve the problem we need to suppose that there is no volume change when salt is added to water. So volume of solution is supposed to be 2 L
Solvent (water) 2 L	$c\left(\frac{g}{L}\right) = \frac{solute\ (g)}{solution\ (L)}$
Solution (salt + water)	$c\left(\frac{g}{L}\right) = \frac{16\ g}{2\ L} = \mathbf{8\ {}^{g}/_{L}}$
Concentration (g/L)?	

b. If we take 150 mL of soup, what will be its concentration?

The concentration is the same in all the sample, so it is 8 g/L

c. How much salt there will be in those 150 mL?

Data	**Solving method**
Solute (salt) ?	Firstly, we need to express the volume of soup in L:
Solvent (water)	$150\,mL \cdot \frac{1\,L}{1000\,mL} = 0{,}15\,L$
Solution (salt + water) 150 mL	$c\left(\frac{g}{L}\right) = \frac{solute\ (g)}{solution\ (L)}$
Concentration (8 g/L)	$8g/L = \frac{salt}{0{,}15\,L}$
	$salt = 8\,{}^{g}/_{L} \cdot 0{,}15L$
	$= \mathbf{1{,}2\ g\ of\ salt\ the\ soup\ contains}$

25. Glucose, one of the sugar's compounds, is a solid substance soluble in water. The solution of glucose in water (serum) is used to feed sick people when they can't eat. In the label of a 500 cm³ serum's bottle it is written "Solution of glucose in water, concentration 55 g/L".

a. Which one is the solute and which one the solvent?

The solvent is water and the solute is glucose

b. We put 50 cm³ of the solution in a dish. When the water evaporates, how much glucose will be on the dish?

Data	**Solving method**
Solute (glucose)?	Concentration is expressed in g/L, so firstly, we need to express volume of solution in L
Solvent (water)	$50\,cm^3 . \frac{1\,L}{10^3 cm^3} = 0{,}05\,L$
Solution (serum) 50 cm³	$C(g/L) = \frac{solute(g)}{solution(L)} .100$
Concentration 55 g/L	$55\,{}^{g}/_{L} = \frac{glucose(g)}{0{,}05L}$
	$glucose(g) = 55\,{}^{g}/_{L} . 0{,}05L$
	$\mathbf{glucose = 2{,}75\ g}$

c. A sick person needs to have 40 g of glucose per hour. How much serum must be given to him per hour?

Data	**Solving method**
Solute (glucose) 40 g	Concentration is expressed in g/L so:
Solvent (water)	$C(g/L) = \frac{solute(g)}{solution(L)} .100$
Solution (serum) ?	$55\,{}^{g}/_{L} = \frac{40\,g}{serum\ (L)}$
Concentration 55 g/L	$serum(L) = \frac{40\,g}{55\,{}^{g}/_{L}}$
	$\mathbf{serum = 0{,}727\ L = 727\ mL}$

26. In the label of an alcoholic drink we can read 13,5% vol.

a. What does that number means?

There are 13,5 mL of alcohol in 100 mL of alcoholic drink

b. If the bottle has a volume of 70 cL, how much alcohol contains?

Data	**Solving method**
Solute (alcohol)	$\%vol = \frac{solute\ (cL)}{solution\ (cL)} \cdot 100$
Solvent (water)	$13{,}5\% = \frac{alcohol\ (cL)}{70\ cL} \cdot 100$
Solution (water+alcohol) 70 cL	$alcohol = \frac{70\ cL \cdot 13{,}5}{100}$
Concentration (% vol) 13,5%	$\mathbf{alcohol = 9{,}45\ cL}$

27. As you know, metallic alloys are solutions in which their components are in solid state. To measure the concentration of gold in an alloy (the other component is usually silver) it is used a unit called carat. A concentration of 1 carat means that from each 24 g. of alloy, 1 g is pure gold.

a. What % mass correspond to an alloy of 1 carat?

We will use a proportion:

$$\frac{1\ g\ gold}{24\ g\ sample} = \frac{x}{100\ g\ sample}$$
$$x = \frac{1\ g\ gold}{24\ g\ sample} \cdot 100 = \mathbf{4{,}17\%}$$

b. What % mass will have an alloy of 18 carats? And one of 24?

Using the same proportion, the sample of 18 carats:

$$\frac{18\ g\ gold}{24\ g\ sample} = \frac{x}{100\ g\ sample}$$
$$x = \frac{18\ g\ gold}{24\ g\ sample} \cdot 100 = \mathbf{75\%}$$

And the sample of 24 carats:

$$\frac{24\ g\ gold}{24\ g\ sample} = \frac{x}{100\ g\ sample}$$
$$x = \mathbf{100\%}$$

What means that the sample is pure gold.

c. Can an alloy of 30 carats exist? Why?

No it can´t because the maximum concentration is 100% that corresponds to 24 carats.

d. How much pure gold there is in a gold ingot of 24 carats of 4 kg?

4 kg of pure gold

28. In the lab there is a flask with HCl with a concentration of 35 % mass.

a. How much HCl there will be in a recipient of 1,5 kg?

Data	**Solving method**
Solute (HCl) ?	We need to use mass concentration equation:
Solvent (water)	$\%mass = \frac{solute\ (g)}{solution\ (g)} \cdot 100$
Solution (HCl solution) 1,5 kg g	$35\% = \frac{solute\ (g)}{1{,}5\ kg} \cdot 100$
Concentration 35% mass	$solute = 1{,}5\ kg \cdot \frac{35}{100} = \mathbf{0{,}525\ kg = 525\ g}$

b. What amount of solution should we take so it has 6 g of HCl?

Data	**Solving method**
Solute (HCl) 6g	We need to use mass concentration equation:
Solvent (water)	$\%mass = \frac{solute\ (g)}{solution\ (g)} \cdot 100$
Solution (HCl solution) ?	$35\% = \frac{6\ g}{solution\ (g)} \cdot 100$
Concentration 35% mass	$solution = 100 \cdot \frac{6\ g}{35} = \mathbf{17{,}14\ g}$

29. We have a solution of sugar in water with an unknown concentration. We take with a pipette 10 mL of that solution, we put them in an evaporating dish and when the water evaporates there are 0, 65 g. of sugar left. What was the concentration of the solution?

Data	**Solving method**
Solute (sugar) 0,65 g	As concentration is expressed in g/L , we need to use solution volume in litres:
Solvent (water)	$10\ mL \cdot \frac{1\ L}{1000\ mL} = 0{,}01L$
Solution (sugar in water) 10 mL	Now the concentration equation is used:
Concentration 50 g/L	$C(g/L) = \frac{solute(g)}{solution(L)}.100$
	$c(^g/_L) = \frac{0{,}65\ g}{0{,}01\ L} = \mathbf{65\ ^g/_L}$

<u>**How much have you learnt?**</u>

30. Think and join:

Sublimation	Iodine and sand	Mixture of solids
Magnetic attraction	Iron filings and sand	Mixture of solids
Distillation	Water and alcohol	Miscible liquids
Crystallization	Water and salt	Liquid and a soluble solid
Decanting	Water and oil	No miscible liquids
Solubility	Salt and sand	Mixture of solids
Selective adsorption	Nitrogen and oxygen	Mixture of gases

31. Explain the techniques of separation mentioned in exercise 1.

a. Sublimation: One of the components in the mixture (iodine) sublimates when heated. Heating the mixture we obtain a gas (iodine)a solid (sand) which are separated.

b. Magnetic attraction: One of the components in the mixture is attracted by a magnet (iron fillings). Putting a magnet closer the mixture iron is separated from sand.

c. Distillation:

32. Complete:

a. A *pure* substance is a material system with a defined composition and specific properties such as *sodium, water* and *iron*.

b. A *mixture* is a material system composed by two o more substances

c. In a *heterogeneous mixture*, components can be distinguished

d. In a *homogeneous* mixture components cannot be distinguished.

e. A *solution* is a *homogeneous* mixture composed by a solvent and one or more solutes.

33. Decide if the sentences about a solution whose concentration is 30% mass are true or false:

a. 100 g of solution has a mass of 30 g

b. There are 700 g of water in 1 kg of solution

c. There are 30 g of solute in 1 L of solution

d. There are a litre of water in a litre of solution

30% means that there are 30 g of solute in 100 g of solution, so a), b) and c) are false.

Let´s analyze b): In 1000 g of solution there are 300 g of solute. Consequently there are 700 g of water. So b) is true.

34. A solution of KCl in water is prepared mixing 27 g of KCl into 400 mL of water. Calculate the concentration of the solution expressed in mass percentage.

Data

Solute (KCl) 27g

Solvent (water) 400mL

Solution (water+KCl)

Concentration (% mass)?

Solving method

Solvent is water whose density is 1g/mL. For that reason, the mass of solvent is 400 g.

$$\%mass = \frac{solute\ (g)}{solution\ (g)} \cdot 100$$

$$\%mass = \frac{27\ g}{427\ g} \cdot 100 = \mathbf{6,32\%\ mass}$$

35. From a solution whose concentration is 40% in mass a portion of 250g has been separated. Which amount of solute does the sample contain?

Data

Solute ?

Solvent

Solution 250 g

Concentration 40% mass

Solving method

We need to use mass concentration equation:

$$\%mass = \frac{solute\ (g)}{solution\ (g)} \cdot 100$$

$$40\% = \frac{solute\ (g)}{250\ g} \cdot 100$$

$$\mathbf{solute} = 250g \cdot \frac{40}{100} = \mathbf{100\ g}$$

36. We have a solution of sugar in water with a concentration of 50g/L. Which volume do we need to get 30 g of sugar?

Data

Solute (sugar) 30 g

Solvent (water)

Solution (sugar in water) ?

Concentration 50 g/L

Solving method

Concentration is expressed in g/L so:

$$C(g/L) = \frac{solute(g)}{solution(L)}.100$$

$$50\,{}^{g}/_{L} = \frac{30\ g}{solution\ (L)}$$

$$solution(L) = \frac{30\ g}{50\,{}^{g}/_{L}}$$

$$\mathbf{solution = 0,6\ L = 600\ mL}$$

37. Vinegar is a mixture of water and Acetic acid. Calculate the mass of Acetic acid which is contained in 500g of vinegar with a concentration of 4% in mass.

Data

Solute (acetic acid)?

Solvent (water)

Solution (vinegar) 500 g

Concentration 4% mass

Solving method

We need to use mass concentration equation:

$$\%mass = \frac{solute\ (g)}{solution\ (g)} \cdot 100$$

$$4\% = \frac{acetic\ acid\ (g)}{500\ g} \cdot 100$$

$$\mathbf{acetic\ acid} = 500g \cdot \frac{4}{100} = \mathbf{20\ g}$$

• LISTENING COMPREHENSION. THE SCIENCE OF MACARRONI SALAD. WHAT IS A MIXTURE?

Se propone otra actividad complementaria relacionada con las mezclas. Se visualiza el siguiente video y se completan los párrafos de la ficha que se presenta a continuación. Se han extraído algunos párrafos del texto. El objetivo es ampliar y ver otros dos tipos de mezclas, las suspensiones y los coloides.

Enlace:

https://ed.ted.com/lessons/the-science-of-macaroni-salad-what-s-in-a-mixture-

THE SCIENCE OF MACARRONI SALAD. WHAT´S IN A MIXTURE?

The world we live in is made of things. These things seem totally different, they're all made of the same stuff, just ______________in different ways.

If you were to reverse a recipe for macaroni salad, you'll see it's made by _____________ together a bunch of ingredients, like macaroni, mayo, vinegar, vegetables, and mustard. This type of combining is called a ______________. When you make a mixture, you're combining two or more things together without changing the ______________ identity of those things.

Like mud, for example. The soil and water in mud haven't actually ______________.

Macaroni salad is actually a mixture of mixtures because many of the ingredients, like mayo and mustard, are already mixtures themselves, which is nice for us because if we look ____________, we'll the see the _____________ main types of mixtures that exist.

The size of the particles in a mixture determines the ____________ of mixture. On one end of the scale is a suspension, like our muddy water example. You get this if you take big chunks of something and mix it with something else so those chunks are just ______________ around. This is called a suspension because you've got ___________________ of one thing suspended in another.

Now, on the other end of the spectrum is a ______________. The particles in this mixture are so small, they are the actual ___________________.

Vinegar is an example of a solution where the molecules of acetic acid are blended with molecules of water. The chemical properties of the molecules haven't ______________, they're just evenly mixed together now. _______________ and carbonated soda are both examples of solutions where other molecules are dissolved in water.

The last type of mixture is called a colloid, which is somewhere between a suspension and a solution. It's when you take two materials that don't dissolve and you make the particles so small that they can't ___________________. Mayo is what happens when you take oil and water, which don't mix, and you bind them _________________, usually with the help of another substance called an emulsifier. In the case of mayo, it's lecithin, found in eggs.

THE SCIENCE OF MACARRONI SALAD. WHAT´S IN A MIXTURE?

The world we live in is made of things, These things seem totally different, they're all made of the same stuff, just *combined* in different ways.

If you were to reverse a recipe for macaroni salad, you'll see it's made by *mixing* together a bunch of ingredients, like macaroni, mayo, vinegar, vegetables, and mustard. This type of combining is called a mixture. When you make a *mixture,* you're combining two or more things together without actually changing the *chemical* identity of those things.

Like mud, for example. The soil and water in mud haven't actually *changed*.

Macaroni salad is actually a mixture of mixtures because many of the ingredients, like mayo and mustard, are already mixtures themselves, which is nice for us because if we look *closely*, we'll the see the *three* main types of mixtures that exist.

The size of the particles in a mixture determines the *type* of mixture. On one end of the scale is a suspension, like our muddy water example. You get this if you take big chunks of something and mix it with something else so those chunks are just *floating* around. This is called a suspension because you've got particles of one thing suspended in another.

Now, on the other end of the spectrum is a *solution*. The particles in this mixture are so small, they are the actual *molecules*.

Vinegar is an example of a solution where the molecules of acetic acid are blended with molecules of water. The chemical properties of the molecules haven't *changed*, they're just evenly mixed together now. *Saltwater* and carbonated soda are both examples of solutions where other molecules are dissolved in water.

The last type of mixture is called a colloid, which is somewhere between a suspension and a solution. It's when you take two materials that don't dissolve and you make the particles so small that they can't *separate*. Mayo is what happens when you take oil and water, which don't mix, and you bind them *together*, usually with the help of another substance called an emulsifier. In the case of mayo, it's lecithin, found in eggs.

MATERIAL DISPONIBLE PARA EL CURSO 2024-2025

También tenemos disponibles los materiales de "Physics and Chemistry" para los cursos de 3º y 4º ESO. Podéis pedir la muestra para visualizar.

Para más información puedes ponerte en contacto para visualizar una muestra completa en educaliaeditorial@e-ducalia.com o en el 610 900 111

MATERIAL DISPONIBLE PER AL CURS 2024-2025

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