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editorial

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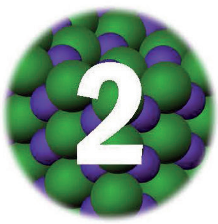
Physics & Chemistry



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

The density of the piece of wood is smaller than the density of water (which is 1 g/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 = ?	There is no equivalence among units. We must use conversion factors
V = 3/4L	
D = 920 kg/m^3	$1 m^3 = 10^3 dm^3 = 10^3 L$

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

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

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

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

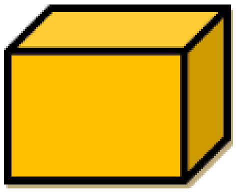
DATA	Solving method
m = 3,5 kg	There is no equivalence among units. We must use conversion factors
V = ?	
D = 2,7 g/cm^3	$1 kg = 10^3 g$

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

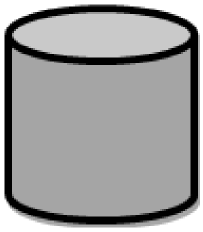
$$D = \frac{m}{V}$$

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

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)

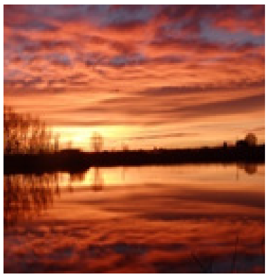
11. A square prism has edges of 5cm, 10 cm and 15 cm. It is made of a wooden whose density is 850kg/m^3 . Calculate its mass.

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

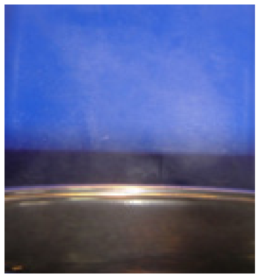
Matter can be in three different states of aggregation: solid, liquid and gas.

Solid

Liquid



Gas

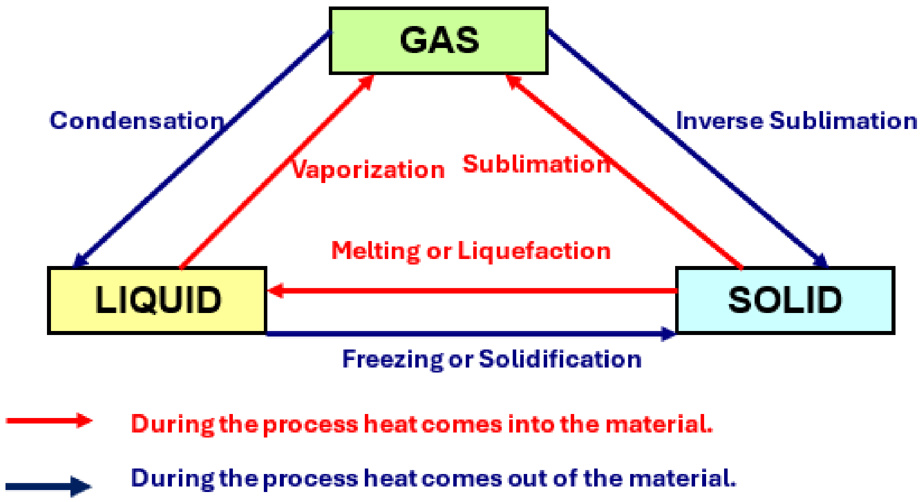


Properties of solids, liquids and gases are summarized in the following table:

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:



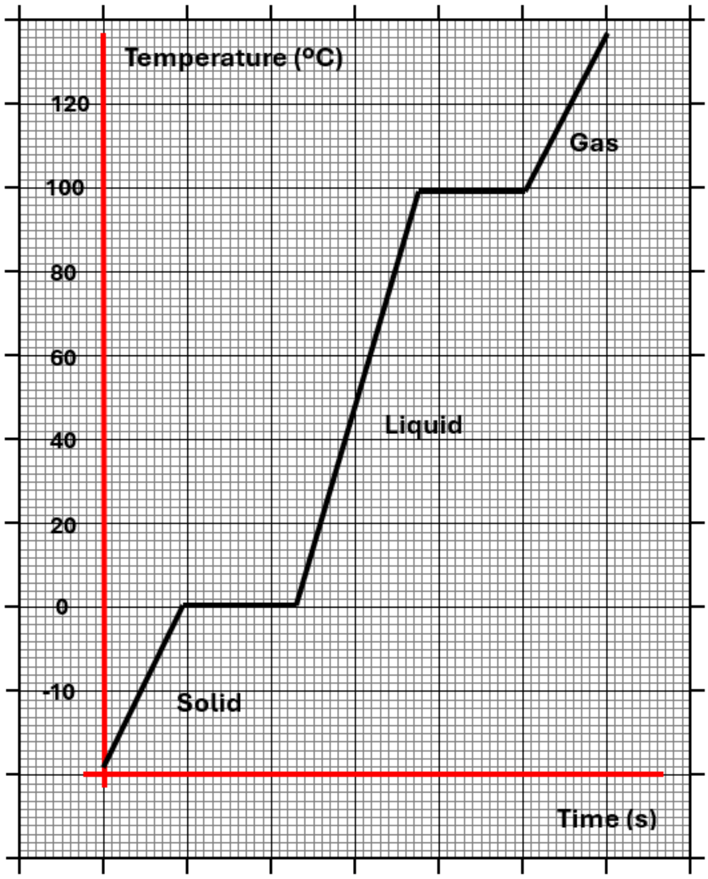
Vaporization includes two different processes:

- **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.

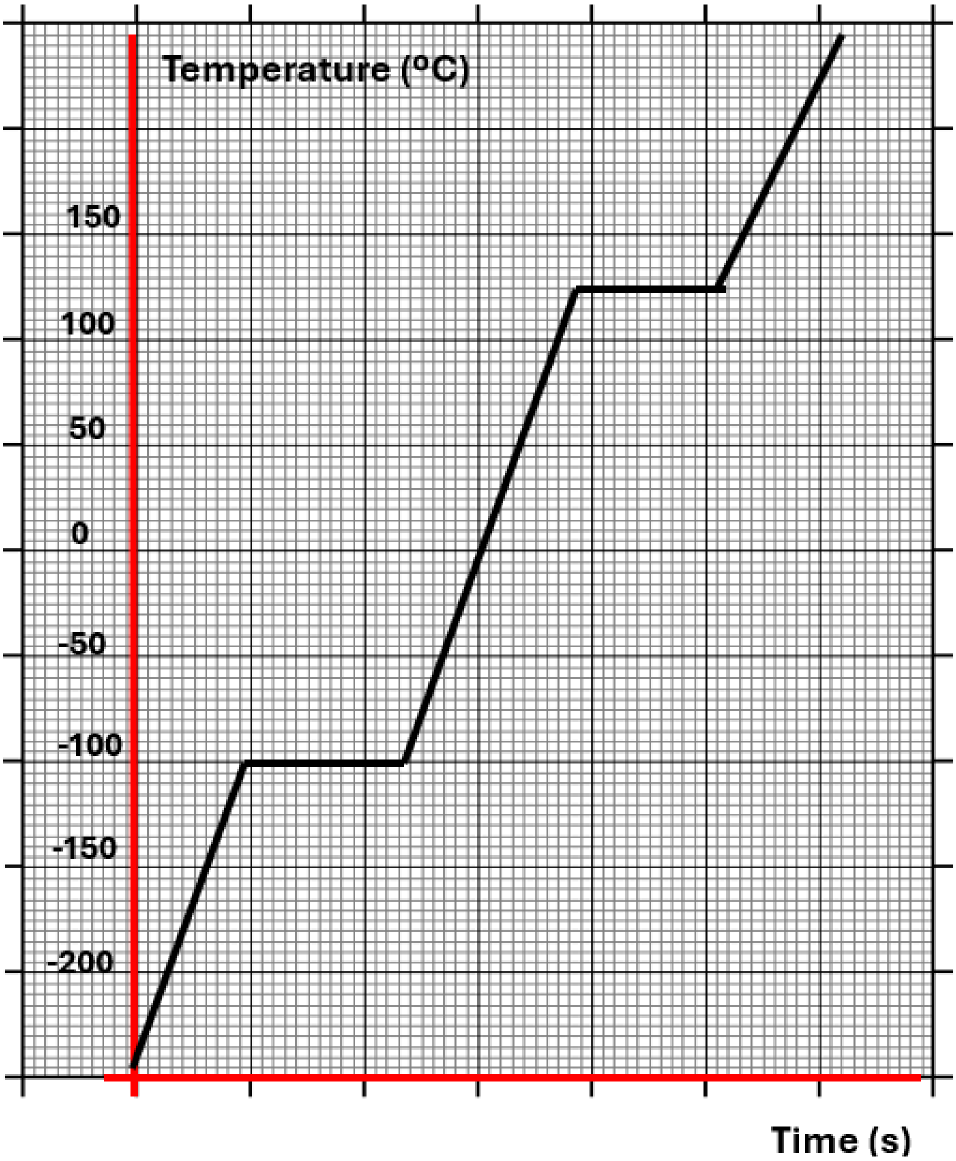
13. When you take a hot shower the bathroom usually gets full of steam. But why does the mirror steam up?

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.

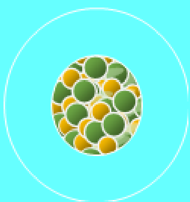
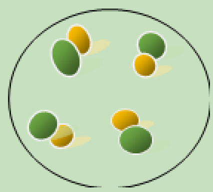


3. KINETIC MOLECULAR THEORY

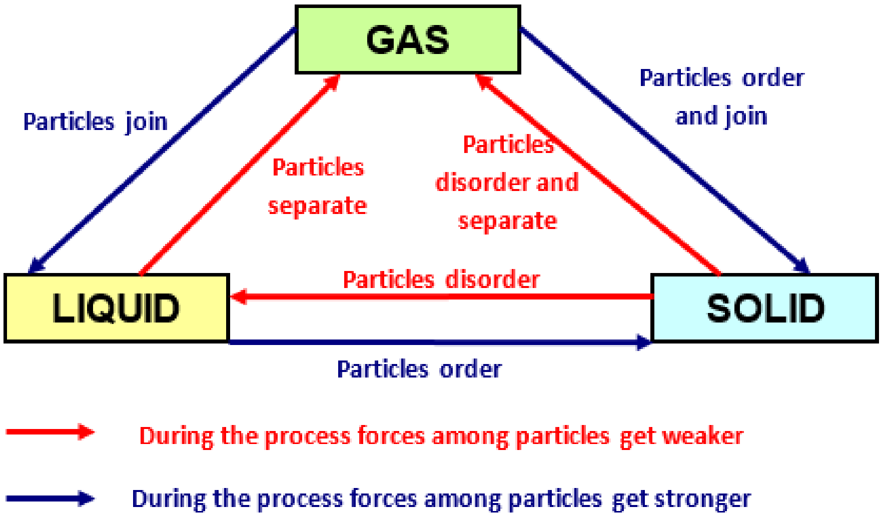
The Kinetic molecular theory explains the differences among the three states of aggregation and the processes involved in the changes of state. It can be summarized in the following points:

- 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 traduced 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
Gas	Can flow	Medium attraction forces
	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...

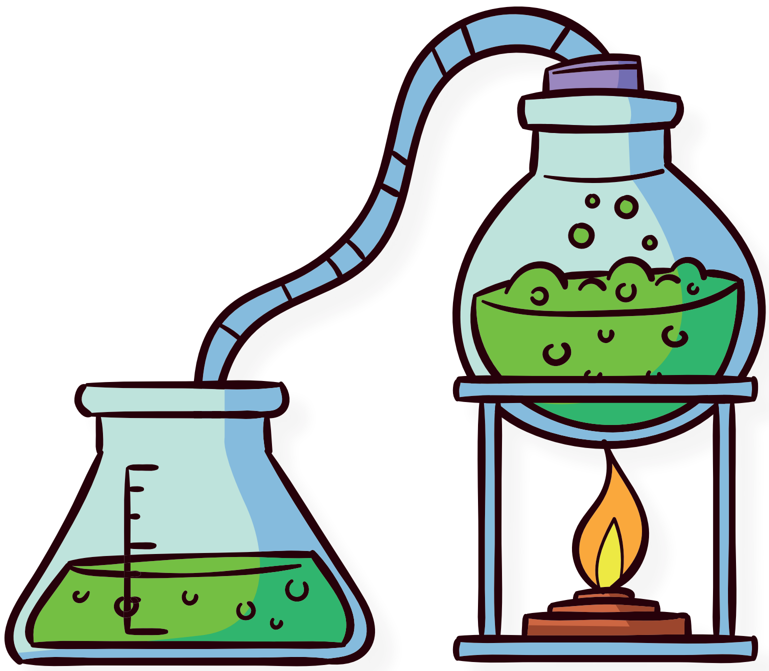
d. A substance change from gas to liquid state. That change of aggregation is called...

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:

$$ºC = K - 273$$

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

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.

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

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.

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

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:

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

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.

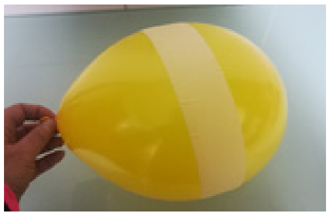
Cover the bottle with your hands to heat it quickly. You can use a heating blanket to heat the bottle.

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?

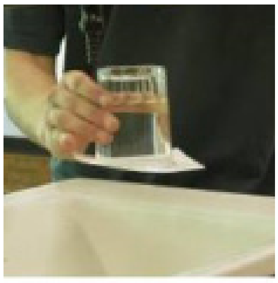
EXPERIMENT 6

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.

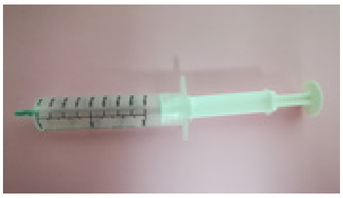


EXPERIMENT 7

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

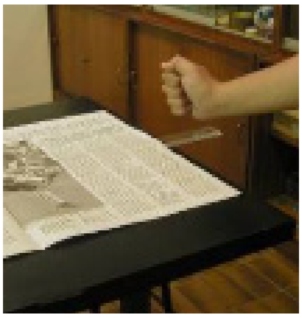
EXPERIMENT 10

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).

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	Joined, Stick, Ordered, Vibrating particles	Melting	Joined, Displacing particles	Vaporization, Evaporation, Boiling	Separating, Displacing particles	Gas laws, To remain, Speed, Rate, Collisions, Frequency
Cylinder		→ Melting point	Medium forces, Container shape, Definite volume, Slightly compressed, To flow, To spread	→ Boiling point	Low forces, Freely moving, To fill the container, To flow, To expand	
Sphere	Fixed position, Strong forces, Fixed shape, Defined volume, Slightly compressed	Freezing ← Solidification		Condensation ← Liquefaction		
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/cm^3 and kg/m^3

61. When we heat 25 cm^3 of a gas contained in a balloon from 25ºC to 80ºC the volume of the gas reaches .... cm^3