Unit 1. Matter

1. Do you know what substance is?



a) Look at the blue liquid in the erlenmeyer on the left, could it be water?
b) Look at the central picture. The liquid in the test tube is odorless. Could it be alcohol?
c) Would you claim that the yellow solid on the right picture is made of gold?

2. New materials (RESEARCH-LABORATORY)

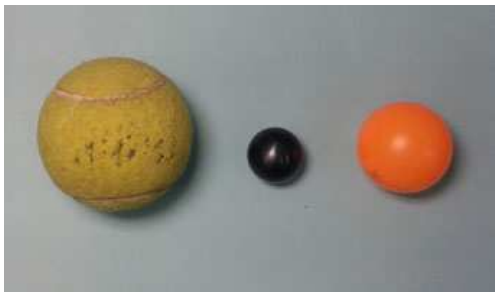
Do research on these four substances: goretex, kevlar, carbon fiber and graphene. Study about their nature and their applications. Use a web searcher to find the information that you need and pictures of the substances and their applications. Make your essay using the information in a way that you understand what you write.

3. Do you know which substance is this?

An unknown substance is liquid at room temperature. Indicate which of the following couldn't be that mysterious substance: water, alcohol, vinegar, aluminium.

4. Comparing mass and volume

Look at the picture, where you can see a tennis ball, a pingpong ball and a steel ball. Order them depending on their mass (feeling the weight of them with your hand) and their volume (observing their size).



5. Which one is the hollow ball?

There are two steel balls with the same volume inside a box. If someone tells you that one of them is hollow (is empty on the inside), how could you know which of them is it?

6. The density of gold

The density of gold is 19,3 g/cm^3, what does it mean? What is the volume of the ingot in the picture? (it is like the ones in the banks in Switzerland).

7. Ordering densities

What is the correct order of densities of the following substances: aluminium, copper, chlorine, ethanol? (use the data table).

a) $d_{aluminium}<d_{chlorine}<d_{copper}<d_{ethanol}$

b) $d_{ethanol}<d_{copper}<d_{chlorine}<d_{aluminium}$

c) $d_{chlorine}<d_{ethanol}<d_{aluminium}<d_{copper}$

d) $d_{chlorine}<d_{aluminiumv}<d_{ethanol}<d_{copper}$

8. Identifying a substance

An unknown substance is solid at room temperature, its melting point is a bit higher than 950ºC and its density is 10,5 g/cm^3. What substance do you think it is?

9. The water inside the bottle

Look at the picture of a bottle of mineral water. Its volume is one liter/litre and a half. What mass of water is there? Remember that 1 cm^3 and 1 ml represent the same volume. Look for the density of water in the data table.

a) 1500 kg; b) 1500 g; c) 1,5 g; d) 1,5 m^3

10. Physical states and density

Use the data table to deduce the order of densities among solids, liquids and gases. Think of two or three known substances for each of the three states at room temperature.

11. Instruments and magnitudes

Look at the pictures and choose which one of them is used to measure each of the following magnitudes: length, mass, temperature, time, and volume.

The scale measures _____

The measuring tape measures _____

The graduated cylinder (test tube) measures _____

The thermometer measures _____

The stopwatch (chronometre) measures _____

12. The length of a table

If you are told that the length of a table is 3,5, do you really know the length of the table?

13. The label of a set of towels

Look at the picture, found in a set of towels. What do you think is wrongly written?

14. Two scales of temperature

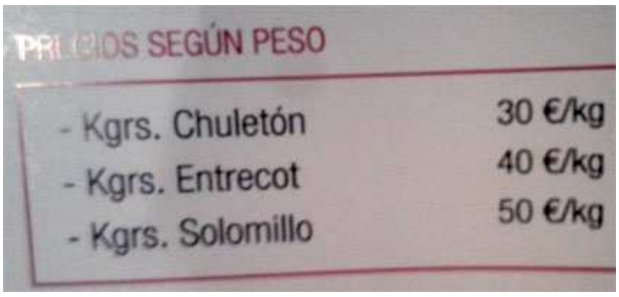
Look at the picture of the thermometer, which measures the temperature both in ºC, used in Europe, and ºF, used in the United States.

a) If the temperature is 40 ºF, is it hot or is it cold?

b) What will be the temperature (ºF) if the thermometer marks 30 ºC?

15. Posters and labels

Look at the pictures and explain the mistakes you find.



16. Numbers in scientific notation

Write the following numbers using scientific notation.

a) 1200 liters

b) 0,028 g

c) 850 seconds

d) 300000 km

17. The mass of a fly

The mass of a fly is about 1,9 10^{-1} g. What is it in decimal notation?
a) 0,019 g; b) 0,19 g; c) 1,9 g; d) 0,019 g

18. The label of a mineral water bottle

The label of a mineral water bottle indicates that it contains 7,4 milligrams of magnesium per liter of water. So that, in a liter of this water bottle there is a mass of magnesium of: a) 7,4 10^{3} kg; b) 7,4 10^{-3} g; c) 7,4 10^{3} g; d) 7,4 10^{-3} kg

19. The mass of a grain of sand

You are told that the mass of a grain of sand is 1,54 mg. Using conversion factors, express this value in grams.

20. The volume of an ingot of gold

Dou you remember the gold ingot in exercise number 6? Its mass is 500 g and, as you know, the density of gold is 19,3 g/cm^{3}. Calculate now the volume using the right conversion factor.

21. Amongst some units and others (RESEARCH-LABORATORY)

Maybe you have heard about how cheap or how expensive the petrol barrel has become, or that a diamond is 12 carats, or that the length of a metal piece is 5 inches. In the picture you can see the "vara jaquesa", sculpted on the right of the front of the “lonja pequeña”, in the Cathedral square of Jaca.

Look for the information that you need to establish conversion factors between:

a) petrol barrels and liters.

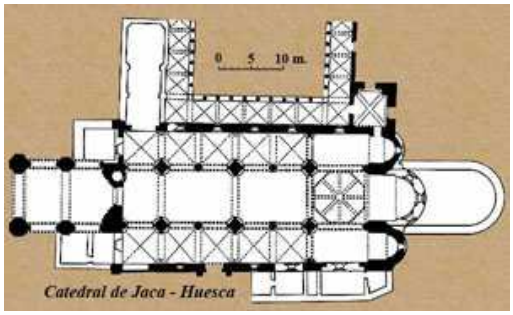
b) carats and grams.

c) inches and centimeters.

d) "varas jaquesas" and meters.

22. In the cathedral of Jaca

The cathedral of Jaca has a width of 20,15 m in the closest area to the apse. What is the equivalence in "varas jaquesas"?



23. The Cullinan I diamond

The Cullinan diamond (Great Star of Africa) weighs 530,20 carats and is the biggest clear cut diamond in the world. It is kept in the Tower of London and is part of the scepter of King Edward VII. How do you express its mass in grams? (1 carat is equivalent to 200 mg).

A) 10,6 g; b) 106 g; c) 265 g; d) 1,06 g

24. The football field of SD Huesca

The Alcoraz field is the football field of SD Huesca team. The pitch has dimensions of 105 x 68 meters. Write the value of the surface in square meters, using scientific notation, and in hectares (1 hectare is equivalent to 10000 m^2 and it is often used in agriculture). Keep in mind the significant figures that you have to use.

25. The weight of a piece of plasticine

You weigh in the scale a piece of plasticine and the value that it shows is 53,4 g.

You divide that piece of plasticine into 10 small pieces of the same mass. What will the scale show if you weigh one of these small pieces?

a) 5,3 g; b) 5,34 g; c) 5,340000000 g; d) 0,534 g

26. Instruments and measurements

a) You need 13,5 ml of one dissolution of physiological serum. What instrument will you use to measure that volume, the graduated cylinder, or the burette?

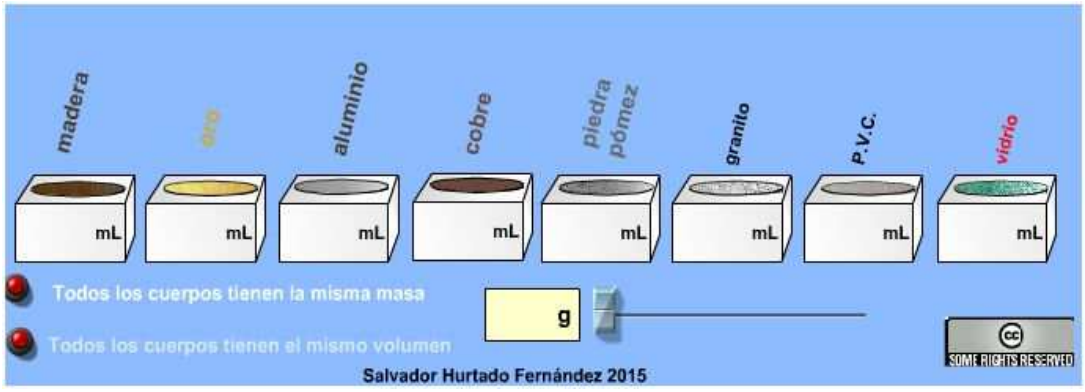
b) In a poster in the fruit store it says that the price of oranges is 1,5 euros/kgr. What is written in the wrong way?

c) If a bag of potatoes of 4 kg costs 3,45 €, can you say that 1 kg costs 0,8625 €, that is exactly 3,45 divided into 4?

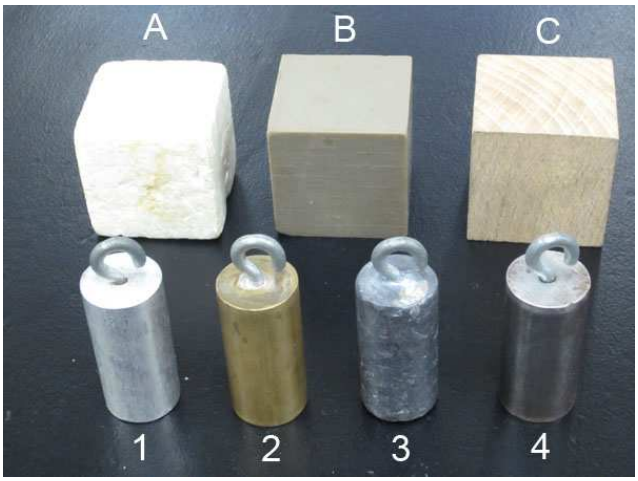
27. The density of substances (RESEARCH-LABORATORY)

Using the web book simulator, deduce (without doing calculations) the order of the densities of all the substances. After that, you have to determine the density value of each one.

You can fix the mass of all the cylinders or the volume of all of them. Design a method to obtain what you need.



28. Identifying materials (RESEARCH-LABORATORY)



At first, you are going to identify the material that some solid objects are made of. The easiest way to know it is by determinating the densities and looking for them in a data table. You will have to consider other properties because some substances have very similar densities. Look at the picture, where you can see three cubes and four cylinders made of different materials. The volume of the three cubes is equal, and the same happens to the volume of the four cylinders. What could you do to order each group by density? You need to measure the mass of every object using a digital scale. The object with the higher mass of each group is the densest because as the volume is the same, the relation between mass and volume will be higher. To weight with the digital scale, start it, wait until it shows 0, put the object in the plate, and write down the mass in grams. Repeat the procedure for each of the seven objects and order them by density. Explain the procedure you have followed, the measurements are taken and your conclusions.

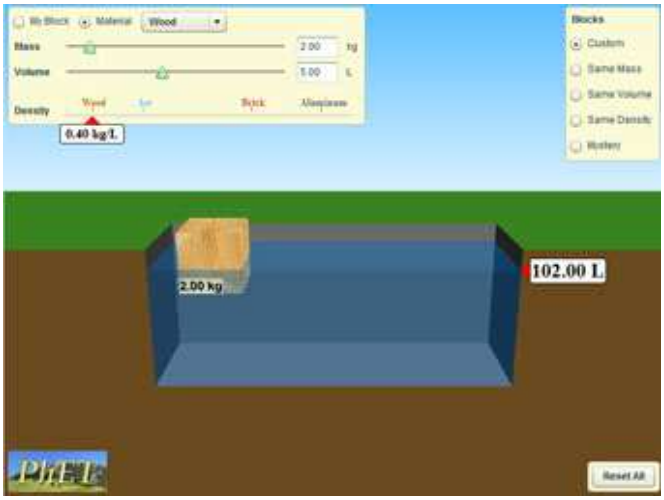
29. In the jewelry

In the shop window of a jewelry shop, there is an ingot made of silver and another one made of platinum. In the two ingots it is written that the mass is 1 kg. Can you identify each one?

30. The density of cubes (RESEARCH-LABORATORY)

Use the next simulator to answer the questions. It is worth to notice that the volume is measured by immersion in water: when the object is completely submerged, the water rises, and that increase corresponds to the volume of the submerged object.

1. Select “Custom” and the material aluminum, setting the volumes 1,2, and 5. What is the mass of the block in each case? Justify it using the value of the density of aluminum. Repeat the work using other materials and check that the conclusion is the same.
2. Select “Same mass”. Determine the volume and the density of the four cubes.
3. Select “Same volume”. Determine the mass and density of the four cubes.
4. Select “Mistery” to identify the material of the five cubes. Show the data table to compare densities and identify the substances.

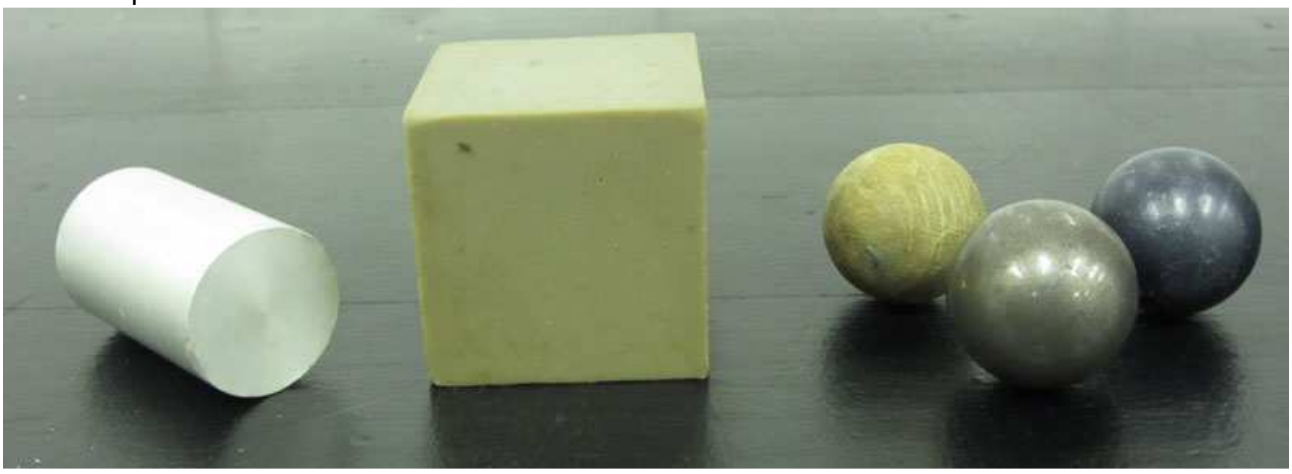


Write down the results and conclusions.

31. Determining the density of a cylinder, a cube and a ball (RESEARCH-LABORATORY)

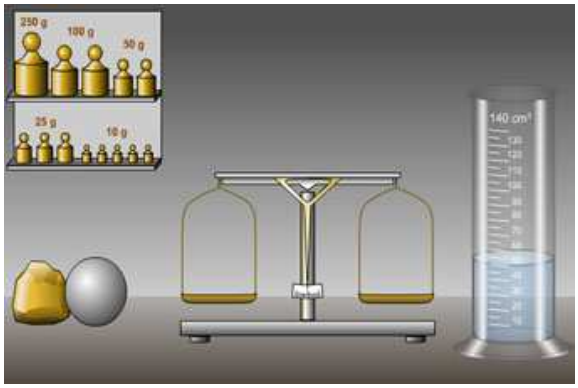
You have to determine the density of a cylinder, a cube, and a ball, similar to the ones in the picture. You have a scale and a caliper, which appreciate 0,1 g and 0,1 cm, respectively. You must express the result in g/cm^3 and kg/m^3, which is IS unit. Using the data table, identify which metals the ball and cylinder are made.

Write the procedure and the results obtained.



$V_{cilindro} = \pi r^2 h$ $V_{cubo} = a^3$ $V_{esfera} = \frac{4}{3}\pi r^3$

32. Identifying metals (RESEARCH-LABORATORY)



With this virtual laboratory, you are going to identify the metal of which the ball and the irregular yellow piece are made. You have a balance of arms: in order to weight, you have to put the object on a saucer and the dumbbells on the other until they equilibrate and the pointer stays in the center of the scale. Look for a good strategy to put the dumbbells!
After that, introduce the object in the measuring cylinder in order to know its volume and so that you will have all the data you need to calculate the densities.
Write down the results. Calculate the densities and look for the values in the data table to know which metals are them. Consider that the numerical result obtained could be an approximation and that the instruments you have used aren't very sensitive.

33. The density of marble (RESEARCH-LABORATORY)

In order to determine its density, you have marble in pieces, water, a watch glass, a measuring cylinder, and a digital scale. Do the measures and calculations that you need and don't forget to write the units and the right number of significant numbers. The density of marble is not in the data table and you must look for it on the web, to compare this value with the one you have obtained experimentally. Describe what you have done and your conclusions.

34. Measuring the volume of trunks

In the sawmills, there are huge trunks, with more or less irregular shapes. How do you think the immersion method is used to determine the volume of the trunks?

35. The golden crown

Look at the next data table and identify which one is the golden crown, which one is silver made and which one is an alloy of gold and silver. Look for the densities in the data table.

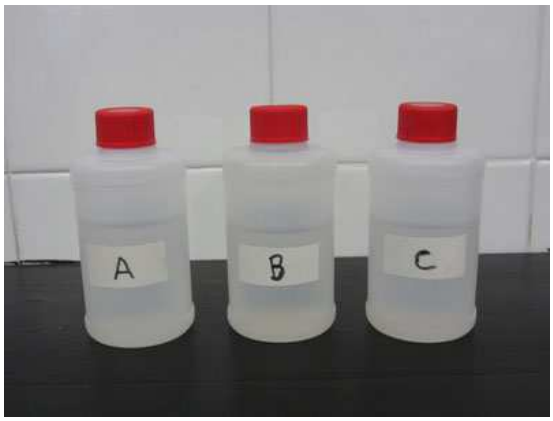
Metal	Mass in g	Volume in cm^3	Metal
A	1247,0	118,8	
B	1247,0	70,0	
C	1247,0	64,6	

Justify if the percentage of gold is higher or lower than the percentage of silver in the "fake" crown.

36. Buoyancy

You already know that iron sinks into the water while cork floats. The reason is that objects denser than water sink into it, while objects less dense float. Density of water is 1 g/cm^3, or 1000 kg/m^3.
A boat has a mass of de 4,5 10^4 kg and a volume of 100 m^3. Justify why it floats even though it is mainly metallic.

37. Identifying liquids (RESEARCH-LABORATORY)



You are going to measure the density of three liquids, labeled in bottles as A, B, and C. Measure the volume using a burette for each liquid, that appreciates until 0,1 ml and the mass with a digital scale.

First, put a beaker in the scale and set the lecture 0 with the Tare button. Put it under the burette and add the volume that you want to the Erlenmeyer (between 10 and 20 ml). Weight the recipient again to now the mass of liquid that it contains. Empty the beaker in the recipient next to each burette and dry the interior of the beaker with filter paper before changing of liquid.

Calculate the densities of A,B and C and try to identify them using the data table.

38. The Tare button of a scale

What is the purpose of the Tare button on a scale?

a) Weight quicker.

b) Discount the mass of the recipient where we have put the substance.

c) Make the result more accurate.

d) Prevent the liquids from evaporation.

39. Graph and densities

Observe the graph. Justify which liquid is denser without doing any calculations and calculate after that the densities of A and B.

40. Properties of mercury

Mercury is the only metal that is liquid at room temperature. It is very toxic: once it enters the body through the respiratory system, as it is very volatile, it never gets eliminated. This is why it is forbidden to make thermometers of domestic use.

It has a huge tendency to form small balls as you can see in the picture. It forms a meniscus in narrow tubes just the other way than in water, as it goes down in the walls instead of going up. Another very special property is its high density, which you are going to calculate know. In order to do that, you add mercury to a measuring cylinder until 25,0 mL. the mass of the measuring cylinder is 83,7 g when it is empty and 423,5 g when it contains the metal. The density of mercury is:

a) 1,36 g/mL; b) 13,6 g/L; c) 13,6 g/mL; d) 13,6 mL/g

41. Experimental determination of boiling points of liquids (RESEARCH-LABORATORY)

To difference liquids, you can determine their boiling points, which is a characteristic property of substances.

Look at the picture, where you can see a beaker with liquid in a heating plate with a magnetic agitator. You can modify the quantity of heat communicated by the unit of time (the power) and the speed of agitation.

The thermometer measures the temperature of the liquid. You have to read it every minute until the liquid reaches its boiling point, writing down the values in a data table.

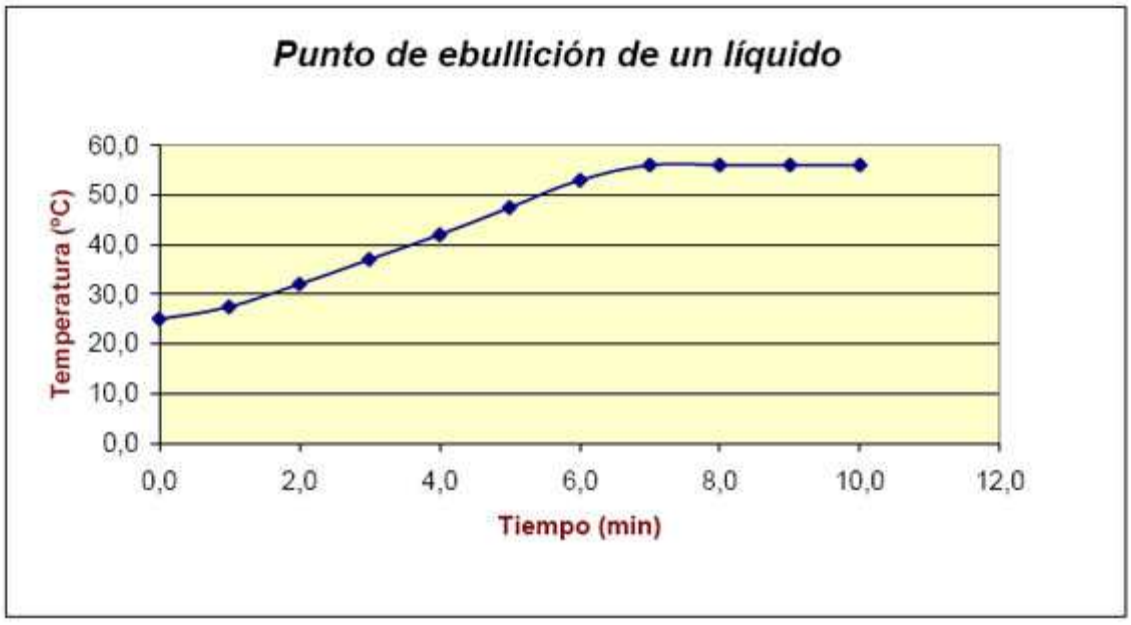
Do the experience with the liquid indicated by your teacher. Notice that once the liquid starts boiling the temperature remains constant. You will learn there a son later. Represent the values in a temperature-time graph and identify the liquid.

42. The boiling point of a liquid

You have obtained experimentally the following data about the boiling point of a liquid, which is represented in the next graphic. What substance is this?

Determinación del punto de ebullición de un líquido

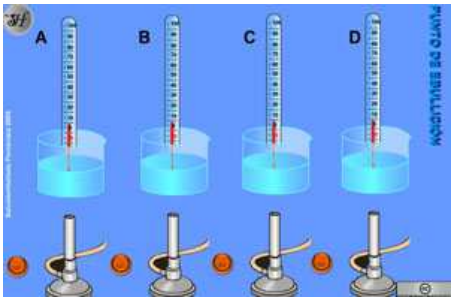
Tiempo (min)	Temperatura (ºC)
0,0	25,0
1,0	27,5
2,0	32,0
3,0	37,0
4,0	42,0
5,0	47,5
6,0	53,0
7,0	56,0
8,0	56,0
9,0	56,0
10,0	56,0



43. And if the hot plate heats less?

How would the previous table be modified if the hot plate would have worked at less power? Would the graphic be different?

44. The boiling point of four substances



Determine the boiling point of each of the four substances by pressing the red button to heat the liquids and make them boil.

a) A:75 ºC; B: 100 ºC; C: 20 ºC; D: 50 ºC
b) A:75 ºC; B: 50 ºC; C: 100 ºC; D: 20 ºC
c) A:100 ºC; B: 50 ºC; C: 75 ºC; D: 20 ºC
d) A:20ºC; B: 100 ºC; C: 75 ºC; D: 50 ºC

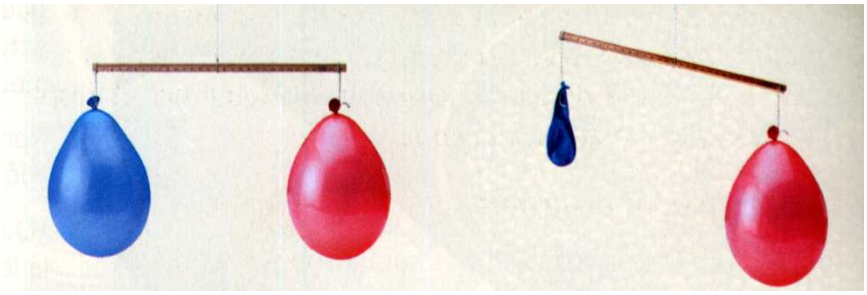
45. Temperature and physic state

Indicate the false statement:

a) At a temperature of 2520 ºC, carbon is in a solid-state.
b) If octane is in the liquid state, the temperature is between -57 and 126 ºC.
c) Ammonium is a gas at temperatures higher than -33 ºC.
d) Mercury is a liquid when there is a temperature of -80 ºC.

46. The two balloons

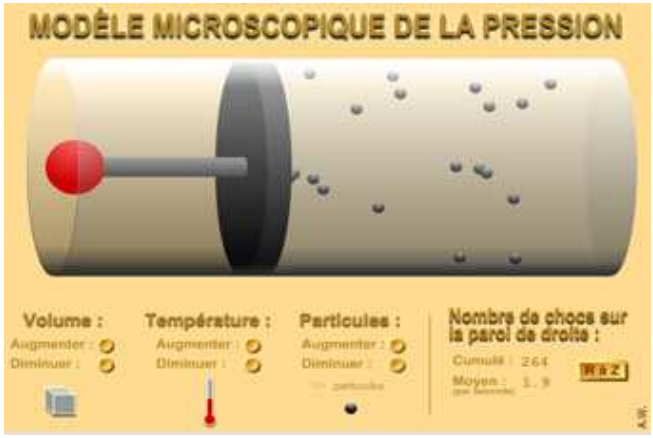
Observe the two pictures. While on the left both balloons are inflated, on the right one of the balloon has been pricked, so that the bar is not balanced. What is the conclusion you obtain?



47. Comparing densities

The density of air is 1,3 g/L, while the density of water is 1000 g/L. How many times bigger is the density of water?

48. A model for the matter (RESEARCH-LABORATORY)



Notice that the simulator is called the "Microscopic model of pressure". It tries to explain the pressure produced by some gas using the model of particles of matter.

In every moment you can check the average of collisions per second between particles and the wall on the right of the recipient. The more collisions, the higher the pressure.

Pressing the right buttons, you can modify the volume, temperature and number of particles and observe how these changes affect the average of collisions (the pressure!)

Don´t forget to put 0 in the counter of collisions once you have changed the parameters (R á Z means to reset a zero), in order to see the new average of collisions. What conclusions do you reach? Do they coincide with the observations about the properties of gases?

49. Substances in solid state

Depending on the physical state, particles are more or less close to each other. Particles use to walk away from each other due to thermal stirring (Brownian movement), which is bigger when the temperature is higher. What is necessary to suppose that happens in order to explain that substances can be in a solid state?

50. Forces in a diamond

A diamond is a substance with a very high melting point, so the attractive forces between its particles are:

a) Very big; b) Intermediates; c) Small; d) The intensity of these forces has no influence on the melting point.

51. Diagram of particles of granite

Observe the picture of granite, which is a heterogeneous mixture of three kinds of substances (Quartz, feldspar, and mica). Represent the particle diagram corresponding.

52. Water with sugar

When you add sugar to a glass with water and you shake it with a spoon, you observe that it is completely dissolved. If you use the spoon to taste the flavor of the dissolution, you observe that it is always the same, not depending on where you take the liquid from. Indicate the false statement:

a) The particles of water and sugar are equally distributed in the dissolution.
b) The mixture is heterogeneous.
c) The distribution of particles in the recipient is homogeneous.
d) If you dissolve more sugar, the flavor is more intense, because sugar produces it.

53. Graphic of heating

The next graphic shows the evolution in time of a mass of a substance that is being heated.
a) Which substance is it?; b) Which is the initial physic state?; c) After how much time does it start to melt?; d) Which is its physic state at 32 minutes?

54. Ice and water (RESEARCH-LABORATORY)

Design an experimental method to compare the densities of liquid water and ice to do it later at home. Describe how you have done the experiment, and the conclusions you reach about densities of ice and water, indicating some practical consequences of the result obtained.

55. There are clothes hanging out

When it is possible, the clothes are hung and well extended to dry them sooner. The reason, following the model of particles, is:

a) If the temperature of the particles is higher, they evaporate sooner.

b) The particles move faster, so the contact surface is better.

c) The particles become smaller when the clothes heat and escape fastly to the air.

d) When heating, the particles occupy more space and escape from the clothes.

56. The balloon that inflates

Look at the picture. On the left, there is an erlenmeyer with air at room temperature. There is a balloon adjusted to the mouth so that the closure is hermetic. If you heat the flask with the flame of a bunsen burner or on a heating plate, you can see that the balloon swells and that when you leave it to cool to room temperature, it returns to the initial situation.

Using the particle model, explain what happens to the balloon.

57. The jumping coin (RESEARCH-LABORATORY)

You are going to experiment at home. Take an empty glass bottle (beer, soda drink...). The bottle in the picture is 1/3 L. Put it inside the fridge and leave it there for at least 30 minutes. Prepare a 50 cent coin and wet it with water. Take the bottle and put the coin on the top. Observe what happens and try hanging the bottle in your hand. How can you explain what you have observed?

58. The pressure of the wheels of a car

Look at the wheel of a car in the picture and observe how is represented the movement of air particles inside it. To work properly, the wheels need to have a concrete pressure. Why do we have to measure the pressure after travelling a few kilometers? Consider that, when the car moves, the wheels rub against the asphalt and heat little by little.

59. The smell of perfume

Since a lot of time ago, one of the most famous perfumes is Chanel nº5. When you open a bottle of perfume inside a room, a little time later the smell can be perceived from every corner of the room. How can you explain it? Why does the perfume smell stronger when it is hot than when it is cold? When do you think the smell will last longer, in summer or winter?

60. Diffusion of colorings

Observe the sequence of three pictures, from left to right. The coloring ends up distributing equally through all the dissolution. You can do it at home using any food coloring added to water (paella coloring for example). How can you justify what happens?