Unit 3. Energy

1. Ways of energy

What is energy? Look at the next images. In which ones you will say there's energy? In which way do you think it is?

1. Ciclista en el Tour de Francia

2. Saltadora de altura

3. Una lámpara iluminando la habitación

4. Concierto de Rock and Roll

5. Un tren en marcha

6. Repostando gasolina

7. Tiradora con arco

8. Un barco movido por el viento

2. Which way of energy it is?

Write down the way of energy you see in each image.

10. Trozos de carbón

11 Carrera de 100 m lisos

12. Agua de un embalse

13. Subidos en la cesta de un globo

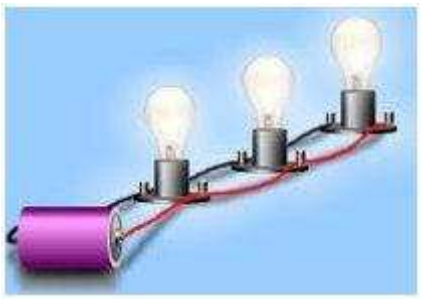
14. Preparando la comida de campamento

15. La casa en lo alto de la montaña

3. The ability to produce changes

Which one of the following systems do you think is more capable of producing changes in the environment? Which kind of changes can produce?

a) A very hot sheet of steel or the same sheet of steel but at 25ºC
b) A car moving with a speed of 60 km/h or the same car with a speed of 100 km/h.
c) A piece of 1 kg of coal or a piece of the same mass but made of wood.



4. Ways of energy (RESEARCH-LABORATORY)

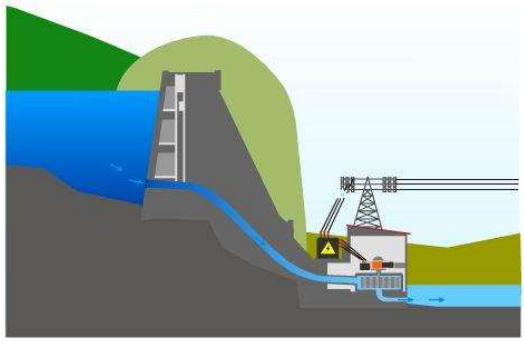
You are going to realise an experiment in the lab in which you are going to use different ways of energy. We are going to use some water in a pan, and we will heat it on a heating plate. We will also need a funnel and a paper pinwheel (you can see how to do it in https://www.youtube.com/watch?v=sO6PyoSECao).

In the first place, we will heat the water until it starts to boil. Then, and very carefully (boiling water burns!) hold the funnel with the narrow end looking up. With the other hand put the pinwheel in the narrow part of the funnel.

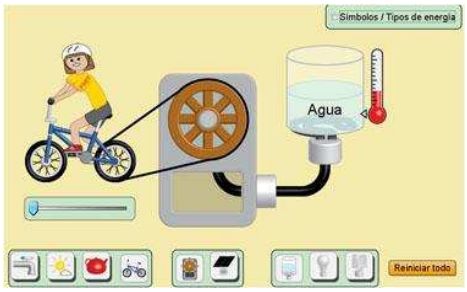
1. What happens to the pinwheel?
2. Write down all the transformations of energy that are taking place. Is there any dissipation of energy?
3. Shut down the heating plate and watch what happens to the pinwheel. Explain what happens using the conservation of energy.

5. Hydroelectric Power Plants

A part of the energy that we use in our homes comes from power plants. There exist different kinds, one of them is the hydroelectric power plants. You can see how they work in the next simulation. Write all the transformations of energy that are taking place.



6. Transformations of energy (RESEARCH-LABORATORY)



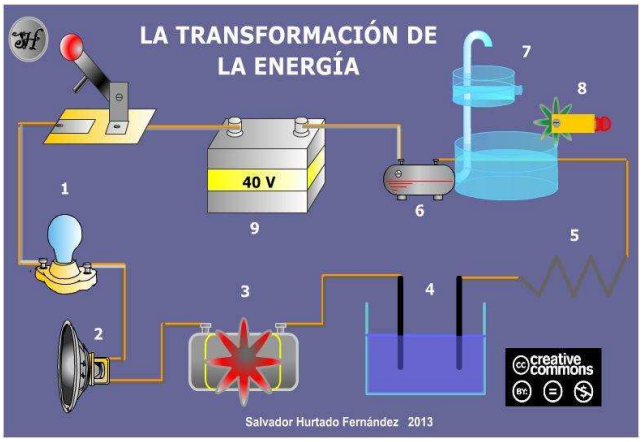
Point out the different ways of energy that appear in each process and how they transform between them.

Notice that you have four different elements to produce energy, two for conversion and three for manifestation. Experiment with the different possibilities (mark the option Símbolos/Tipos de Energía and you will see better what's going on).

1. Choose the tap and open it.
2. Select the teapot and heat it.
3. Use the kid with the bike. What happens when it tires up?
4. Follow the instructions of the teacher and analyse some of the energy transformations that you can see.

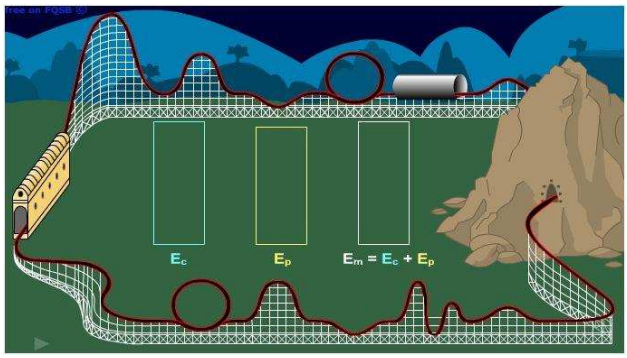
7. Transformation of electrical energy

Connect the circuit and indicate the transformations of energy that are happening in each case.



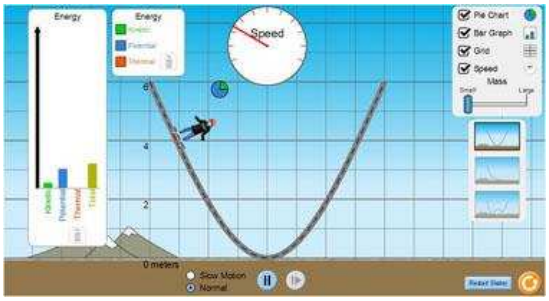
8. Roller coaster

Look at the movement of the point that represents the wagon in the roller coaster. See how the kinetic (higher for higher speeds) and potential gravitational (bigger at higher heights) energies change. How is being modified the sum of both energies? What do you think that is going on when the wagon is breaking?



9. Let 's skate! (RESEARCH-LABORATORY)

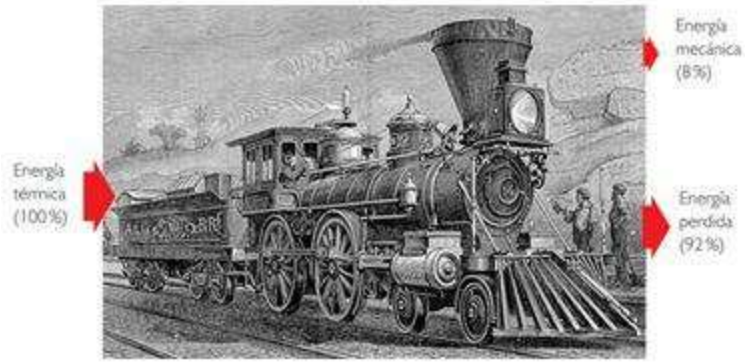
Select *Intro*, activate the four boxes of graphic information and see how the kinetic and gravitational potential energies evolve. Change then the mass of the kid to see if it has any influence on the movement.



10. Steam train

The trains that burn coal worked up boiling the water to move a turbine that made the wheels rotate, and so, the train advance.

Was the steam train an efficient machine? It transformed the energy from the coal into the energy we want?

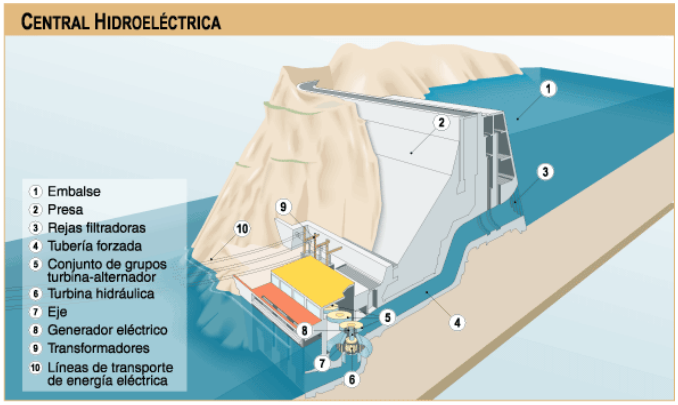


11. Batteries and light bulbs

The next image shows a battery lighting some bulbs. Draw the energetic diagram and establish which of the energies produced are useful and which not.

12. In the Hydroelectric Power Plant

Draw the energetic diagram of the process that is taking place in a hydroelectric power plant.



13. In the city

Make the energetic diagram for the use of the electrical energy that has been just produced in a hydroelectric power plant. You can use this two images for help.

14. Travelling through the Pyrinees

Make the energetic diagram of a car that is travelling through the Pyrinees at night.

15. Pushing the elephant

After a lot of exhausting hours pushing a stubborn elephant, and besides all the sweat and the effort, the poor kitty hasn't done any work over the elephant if it hasn't moved. Do you agree with this statement?

16. Carrying the suitcase

Look at the image, in which a woman is carrying a 5 kg suitcase. If you lift it into the trunk of a car, you do a job.

Would it be higher if the suitcase was 20 kg? What if you have to carry the suitcase to the fifth floor of a house, walking up the stairs because the elevator is broken?

17. Hot or cold? (RESEARCH-LABORATORY)

Fill a glass with hot water, another with warm water, and finally another with cold water.

Put your right hand in the hot glass and your left hand in the glass of cold water. After a few seconds, put both hands simultaneously into the bowl of warm water.

Do you feel the same sensation of heat or cold in both hands? Do you think that the sense of touch allows us to know the temperature of an object with the same accuracy as a thermometer? Why?

18. Diffusion of ink in water (RESEARCH-LABORATORY)

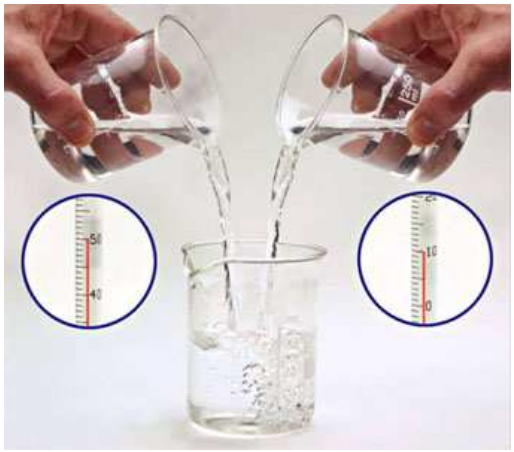
Put 200 cm^3 of hot water in a beaker. In another, add 200 cm^3 of cold water. Add a drop of food colouring to both. Observe how it falls and spreads through the water (diffusion).

In which container has the dye diffused the fastest? How do you explain this fact?

19. Thermal equilibrium

Predict what will happen to the temperature when you mix 100 cm^3 of hot water with another 100 cm^3 of water at room temperature.

Design an experiment that allows you to test your predictions and carry them out in the laboratory. Are your predictions confirmed?



20. Heating water (I)

How much heat measured in calories must be provided to 200 g of water to raise the temperature from 20 to 21 ºC?

21. Heating water (II)

If you want to heat a kilogram of water from 20 to 25 ºC, how much energy in the form of heat do you have to communicate? Express the result in joules, calories, and kilocalories.

22. Temperature and heat

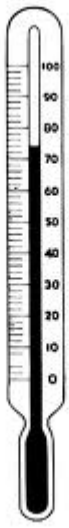
Justify whether the following statements are true or false:
a) When an object increases its temperature, the speed of its particles increases.
b) Boiling water is hotter than cold water.
c) To increase the temperature of an object you have to provide it with heat.

23. Kinetic energy and heat

Take a look at the comic strip below, where a joke is made about the transformation of kinetic energy into heat. Indicates other cases in which this transformation occurs.

24. Dependence on the mass of the substance (RESEARCH-LABORATORY)

We are going to design an experiment to verify that the increase in temperature of a substance depends on the amount of mass of the object. We want to demonstrate that when we give the same amount of heat to a substance, the temperature rises more quickly in the case of having less mass and more slowly when the mass of the object is greater.



You have 3 beakers of 100 cm^3. You will add 25 cm^3, 50 cm^3 and 75 cm^3 of water at laboratory temperature. The markings on the glass are enough to make an approximate measurement.

You also have an electric burner, three thermometers and a support to hang them without touching the bottom of the glass with liquid.

Turn the burner on medium power and take measurements every 30 seconds until 60 ºC is reached. In the work group, one of the members measures the times and three others read and record the three temperatures.

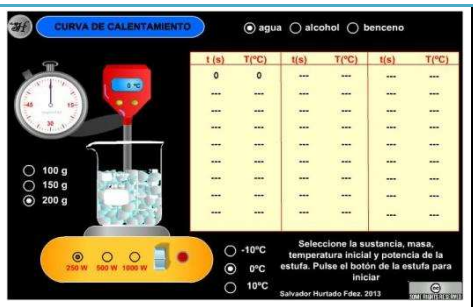
Record the data using the temperature (ºC) and time (s) data collection tables for each body of water and make the three temperature (ºC) / time (s) graphs.

Compare the three graphs. What conclusions do you get?

25. Heating different substances (RESEARCH-LABORATORY)

Now you are going to work with a virtual laboratory to see the influence not only of the mass but also of the type of substance and the power of the heating plate. The three substances you are going to work with are water, alcohol and benzene, and you can choose between three masses and also between three powers.

Determines the influence of the mass and the power of the heating plate on the temperature reached after a certain time. What substance heats up most easily? And which is the most difficult to heat up? If you wanted to use one of the liquids as a thermal insulator, which one would you choose?



26. Heating water(III)

You have two containers with water, one with 500 g and the other with 1 kg, at 20 ºC in both cases. If you put them in the same heater, which one will reach 50 ºC first?

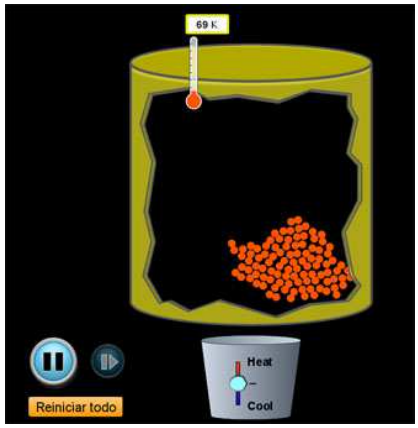
27. Dilatation of a gas (RESEARCH-LABORATORY)

Make the experiment of the figure, heating the flask containing air with your hands. What do you observe? Would it be better appreciated if the jar had been in the freezer before?

28.Comparing dilations

What expands more, a solid, a liquid or a gas? Why?

To justify your answer, use this virtual laboratory, in which you can compare the behaviour of solids, liquids and gases when they heat up and their temperature increases.



29. Does it go through the hoop? (RESEARCH-LABORATORY)

Make the experimental setup and observe how the object passes very right through a ring. Heat the object and see what happens. Which is the reason?

30. Expansion joints

Look at the following images, which correspond to four types of expansion joints. Indicate the objective they have in each case.




31. Reinforced concrete

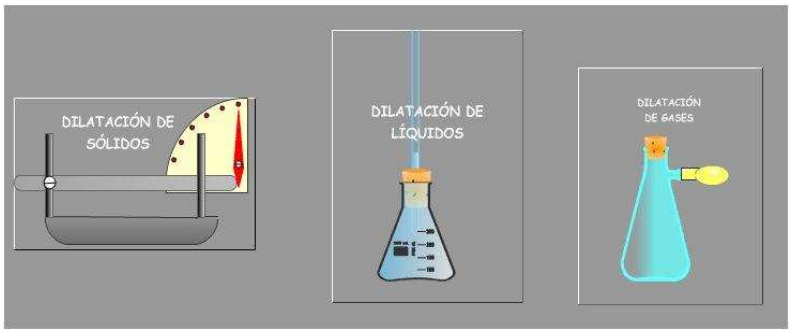
Concrete and steel expand similarly with temperature. Explain why this fact is vital to the use of reinforced concrete in construction. Look at the images below, which show thermal expansion problems in a bridge.

32. Car coolant

In the expansion tank of the radiator of a car, there is a signal of maximum filling. Think about reason for this safety sign.

33. The dilatation of substances (RESEARCH-LABORATORY)

Use the virtual laboratory to determine which substance expands the most among those proposed in each of the three states of matter.



34. Between pans and pots

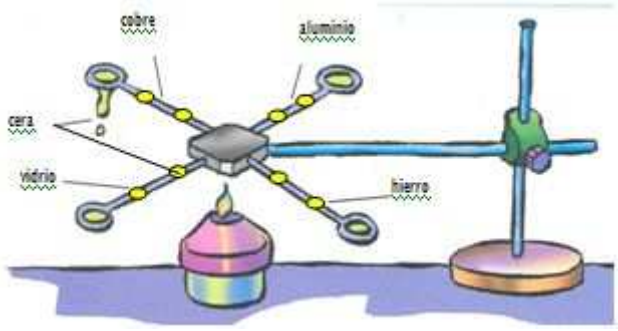
Why are pans made of metal? Why are the handles made of plastic or wood?

35. Thermal conductivity of materials (I) (RESEARCH-LABORATORY)

Place four rods of different objects: glass, copper, iron and aluminium, in contact with a central metal disk and a little wax at fixed distances on each of the rods.

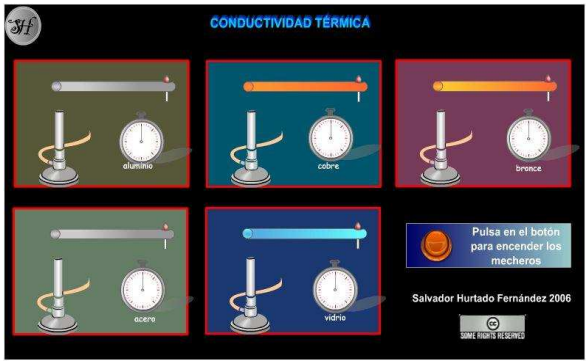
Heat the central disk with a Bunsen burner and note the heating time needed to melt the wax on the different rods.

Explain this fact and order the substances in order from highest to lowest conductor of heat.



36. Thermal conductivity of materials (II) (RESEARCH-LABORATORY)

Use the simulator to order the heat conductivity of the five materials.



37. Heat conductor or insulator?

The data in the table indicates the thermal conductivity of different substances or materials. Some are good thermal insulators while others are good heat conductors.

Classify the following materials into good and bad conductors of heat: copper, glass, ceramic, aluminium, brass, plastic, water and air (in some cases the data does not appear in the table).

38. Serving food

Look at the picture. Think about if want the pasta that has just come out of the oven to cool quickly, or the soup or any other cooked food that is served at the table. What materials do you think should be used to serve the food we eat?

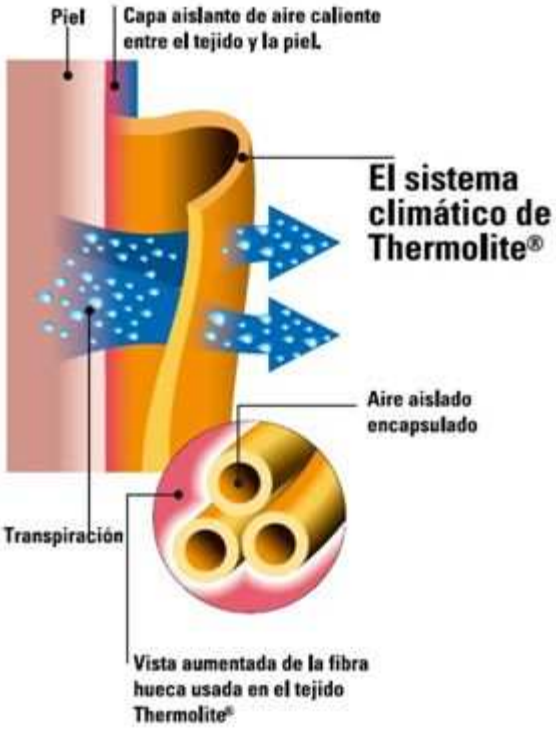
- Those that transmit heat quickly.
- Those that prevent heat from being transmitted quickly.

39. Natural and artificial insulators

A brand of sportswear made with Thermolite makes the following announcement:

a) If you analyze the image of the advertisement, what do you think is due to the insulating effect of sportswear?

b) Does it have any similarity to the way animals have to insulate themselves from the cold (with skin, hair, wool)?

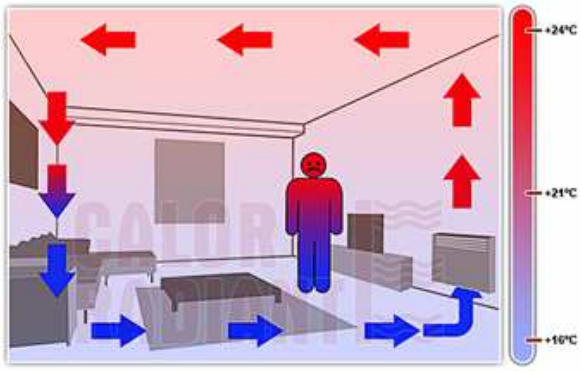


40. Radiators

The propagation of heat by convection is a good way to heat our houses. You have a simple diagram of how a radiator works in the image on the right.

Why do you advise putting radiators under windows? Are they thus placed in your house?

Suggest the reason why the wall above the radiators always ends up dirty.



41. Dyes in water (RESEARCH-LABORATORY)

Add room temperature water to a crystallizer.

You have two small jars with coloured water. One of them, with red dye at 60 ºC, and the other with the blue dye at 5 ºC. Place the two jars in the bottom of the crystallizer.

a) What do you observe?

b) How do convection currents move in water?

42. Convection in liquids and gases (INVESTIGATION-LABORATORY)

Now you are going to see two cases of heat transmission by convection, in the case of a liquid and in that of a gas.

Lava lamp

a) What do you observe when heating the liquid contained in the "lava lamp"?
b) How do convection currents move in water?

Convection pinwheel

In the case of air heating the candle, what path does the hot air follow? What effects does it have on the pinwheel?

43. Toasting bread

Nadia and Marta are toasting a slice of bread over the fire and are surprised that it gets toast very quickly. Nadia says that it is due to radiation and Marta that conduction and convection also influence. What do you think?

44. Heating water with a light bulb (RESEARCH-LABORATORY)

Illuminate a beaker containing 200 cm3 of water with a directional spotlight. Insert a thermometer the moment you turn on the bulb and write down the initial temperature.

a) How is the water temperature changing?

b) Place reflective paper between the bulb and the glass. Do you observe the same increase of temperature?

c) What would happen if you put the thermometer in a hood with vacuum?

45. The solar cooker (RESEARCH-LABORATORY)

In power plants, you have already seen that one way to heat water and even vaporize it is to set up a solar cooker: it is a reflective parabola that concentrates the sun's rays at one point and manages to greatly increase the temperature in it. Take a look at the image of a didactic solar cooker and also at the video, in which the energy concentrated at that point produces impressive effects.

It is about you designing and assembling a solar kitchen with homemade materials. The objective is not that it be very aesthetic, but that it be useful, that it heats the water. You will work in groups with your classmates.

46. Isolating your house (RESEARCH-LABORATORY)

Can you think of any way to improve the thermal isolation of your house? Search for information in newspapers, magazines, specialized stores, the Internet, etc.

47. Energy appreciation of your house (RESEARCH-LABORATORY)

Make a diagram of the plan and elevation of your house, indicating its orientation (North, South, East and West) and indicate which walls face the outside or other adjoining rooms. It also indicates glass windows and doors.

a) Why do the exterior walls lose more heat?

b) What type of thermal insulation do they have?

c) Does it affect heat loss if there are glass windows? Or are the losses caused by the window frames?

d) Is there heat loss through the doors?

On the plan of your house, make an assessment of the heat losses at each point that you consider relevant.

48. Reasons to save energy

Besides reducing the economic cost, what other reason is there to save energy?

49. Factors influencing thermal isolation (RESEARCH-LABORATORY)

Now you are going to study how a series of factors such as the type of thermal insulation, the design characteristics of the building and its orientation influence the temperature of a home.

You have a wooden box that has a small door and a foam cardboard roof with an air chamber inside. Inside the house, the probes of two thermometers are placed at different heights, and there is a 400 W halogen light bulb to simulate the effect of sunlight.

You are going to assume that it is summer. For this purpose, you place the light about 60 cm from the house.

a) Make a table of the interior temperatures as a function of the lighting time. How are the temperatures evolving? They are equal?

b) Place different insulators inside it, such as white cork, foam cardboard, padded fabric and repeat the measurements. Are all insulators the same efficiency? Which one would you choose for your home?

c) Place the roof that provides you with an air chamber and takes the measurements again. Is the air chamber useful for anything?

d) Now put a reflective paper or a small mirror on the door and repeat the measurements. Do you notice any difference?

e) Finally, you are going to study the effect of the colour of the walls. For this, you have a black and white card, already cut to the size of the walls. Investigate the effect they have on the indoor temperature.

Finally, summarize the conclusions obtained and prepares a proposal to improve the insulation of a home.

50. Heat transmission in buildings

Use the image and what you have worked on about thermal insulation to indicate in which cases the transmission of heat is carried out by conduction, convection or radiation.

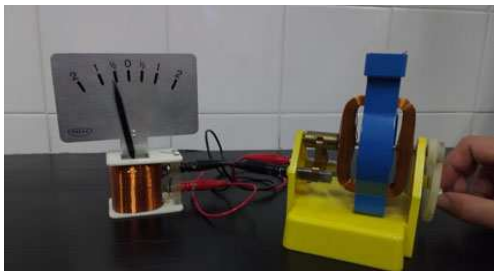
51. What are the uses of electrical energy?

Indicates ten examples of the use of electrical energy, covering both the home and the industry, services, transport, etc.

52. Generating electricity (RESEARCH-LABORATORY)

In the laboratory, you can generate electricity using an alternator that rotates manually, as you have in the image, but also with photovoltaic panels that produce movement, light or sound...

Use the materials you have in the laboratory to produce electrical current.



53. Energy transformations in wind turbines

Represents an energy diagram with the transformations that take place in wind turbines. Consider that the energetic efficency is 20%.

54. Energy transformations in biomass plants

Represents through energy diagrams the energy transformation process that takes place in a biomass plant, taking into account that its energetic efficency is approximately 30%.

55. Where would you install power plants?

a) If you had to choose the location of a solar plant, would you suggest Andalusia or Galicia?
b) Do you think that Spain is an appropriate country for geothermal power plants?
c) Where do you think it is more interesting to install a tidal power station, on the Mediterranean coast or the Atlantic?

56. Electricity demand in real-time

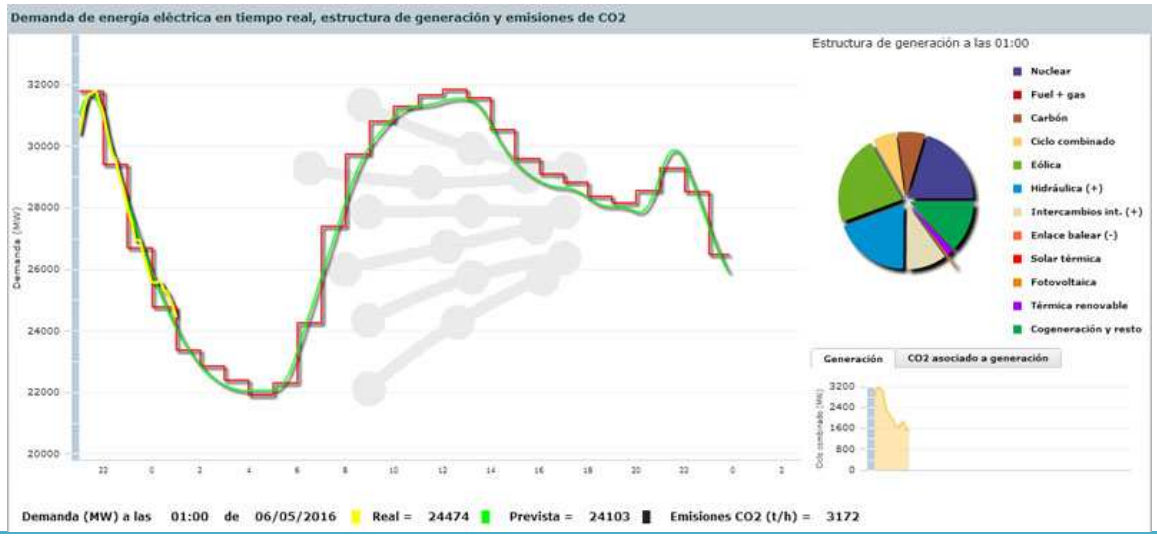
Look at the graphic above and answer the following questions:

a) At what times of the day do the maximum and minimum demand for electrical energy take place?

b) Give a explanation to those observations.

c) Why is there no solar energy production at the time the data was collected?

d) Do you think there will be differences in these demand graphs between one day in January and another in July?



57. The hairdryer

Look at the hairdryer in the picture. If a family uses it for two hours every day, how much electrical energy measured in kWh will it consume in one month of April?

58. Waves in strings and springs (RESEARCH-LABORATORY)

Using a long, flexible string or spring, try to produce a wave motion that is sustained over time. It is much simpler than it seems: you only have to maintain a regular vertical movement up and down and you will obtain a result similar to the one of the simulator. Can you get higher or lower frequency waves?

59. The diapason (RESEARCH-LABORATORY)

Hit a diapason with the mallet and notice the sound it produces, high or low. Repeat the process with another identical diapason and bring them closer. Observe how they interact.

60. Does sound propagate in a vacuum? (RESEARCH-LABORATORY)

You are going to investigate how a mobile sounds inside a container from which the air has been extracted, that is, in a vacuum hood. Insert a colleague's cell phone into the vacuum hood. It is placed on a soft surface, to avoid the transmission of sound through the floor of the hood. The mobile must have the call activated with the maximum volume and the vibration system blocked. Once enough vacuum has been made, another colleague will make a call to the mobile. Can you hear the mobile? What if you eliminate the vacuum by letting the air in? What conclusion do you get?

61. Space battles

As you can see in the video, an essential element in all science fiction films are the battles between spaceships: space cruisers or small assault ships that move in the interstellar vacuum at hyper luminal speeds and that with the extraordinary aim they succeed in shooting down to the enemy ships, between enormous flashes and noisy explosions .
Review these scenes based on what you have learned about sound.

62. The sonic plane of the Institute (INVESTIGATION-LABORATORY)

Between the whole class, you are going to elaborate a the sonic plane of the Institute. To do this, you will form groups of four and take data three times during the morning at the four points assigned to you.

You will need a map of the area of the Institute where you are going to take the measurements, as well as a sound level meter. As there are applications available, you will install on your mobile the one indicated by the teacher and you will use it to make the measurements.

Does the sound intensity ever exceed the recommended levels in normal situations (65 dB)? Are you getting closer to the danger zone of more than 100 dB?

63. Spread of light (INVESTIGATION-LABORATORY)

Observe the straight profile with which the light is spread from a powerful spotlight, such as an old slide projector or the projector of your classroom.

Using the same source of light projected on a white background, such as the digital whiteboard or the projection screen, place geometric objects, such as a notebook, a ruler or a pen and observe the effect caused on the white background. Draw the effect produced in your notebook.

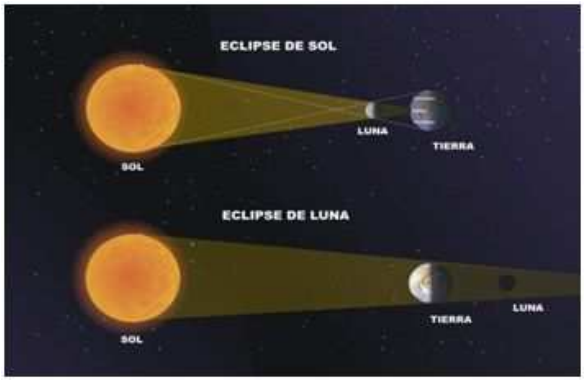
Finally, place a ball in front of the beam of light and see what effect it has on the white background.

64. Eclipses (RESEARCH-LABORATORY)

Using the same light bulb, two polystyrene balls and with the help of two students, we are going to simulate an eclipse of the Moon and an eclipse of the Sun. Look at the images to understand how eclipses occur.

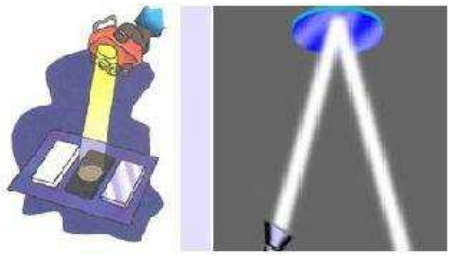
What conclusions can you draw about the way the light coming from the bulb spreads?

Use the simulator to control the processes in which the two types of eclipses occur. See what would happen if the Moon were bigger or smaller, or if it were closer to or further from the Earth.



65. Illuminating surfaces (RESEARCH-LABORATORY)

Use a spotlight or a flashlight with a very narrow beam of light to shine a light on different materials: a mirror, a polished sheet of metal, a piece of white cardboard and a black piece. What effects do you see in the four cases? What if you illuminate with the tilted flashlight?



66. How is the image that a mirror forms?

When light falls on a perfectly flat surface, such as polished metal or glass, all the rays striking the surface parallel are reflected in parallel. We speak of a specular reflection.

a) Look at yourself in a mirror and wink with your left eye. What is the eye that winks in your image?

b) Write your name on a sheet of paper and place it in front of the mirror. How is the image you see?

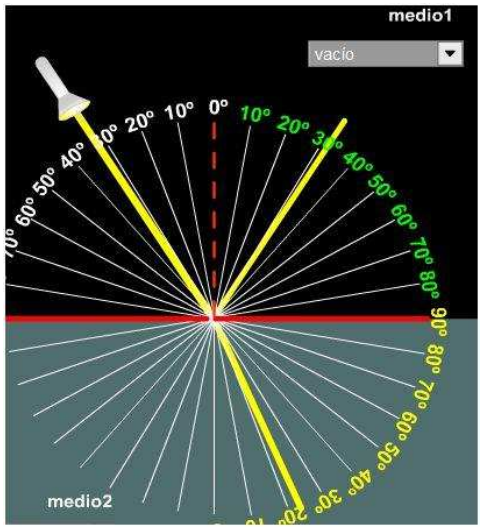
c) Why does the word ambulance appear like this?

67. The light is deflected (INVESTIGATION-LABORATORY)

Partially insert a pencil into a glass of water and look at it from different positions. What seems to happen to the pencil? Place a coin in the bottom of an empty cup or empty glass with the side surface lined with paper. Stand away from the cup or glass just until you can't see the coin. Without moving your head, slowly add water to the inside of the cup (make sure the coin doesn't move when adding water). Using the video, draw a picture of what you have observed.

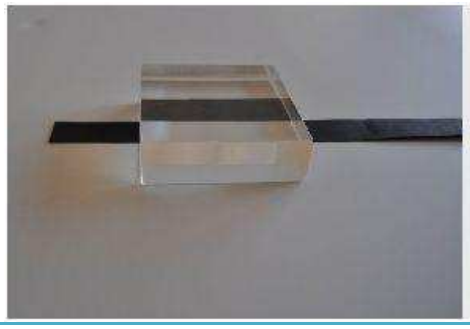
68. Laws of reflection and refraction (RESEARCH-LABORATORY)

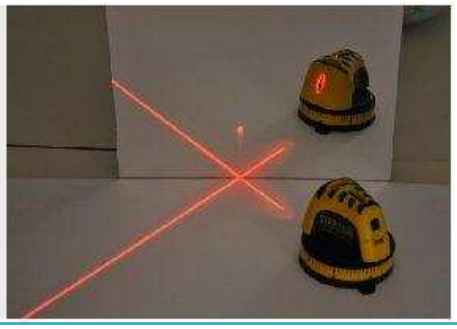
Use the simulator to determine the angles of incidence and reflection of a ray striking a surface. Change the medium to see if it affects what you have observed (air, water, glass). Now see what the angles of incidence and refraction are like. In which medium is there the greatest deflection of light?



69. What is taking place?

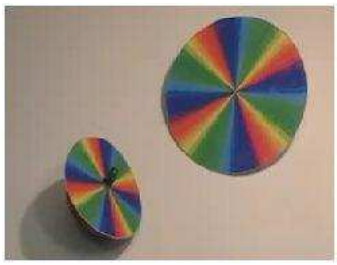
Take a look at the pictures below. Indicate what phenomenon takes place in each one of them and explains what is observed in each case.





70. Newton's disk

Newton's disk consists of a rotating disk on which the seven colours of the rainbow are drawn. What happens when I spin the disc? What conclusions can you get from the colour mix?



71. What happens when light passes through a prism? (RESEARCH-LABORATORY)

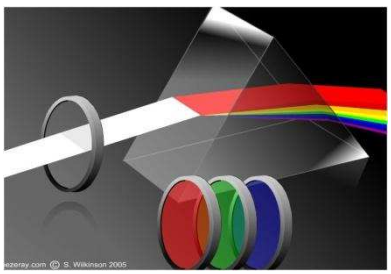
a) Using a ray of white light, make it strike a glass prism and collect the refracted ray on a screen.
b) Describe what you see on the screen. How many different colours can you distinguish?

72. Sunbathing

In summer it is fashionable to sunbathe to make your skin brown. But burns often occur from sunbathing too long, or because doing it in the middle hours of the day, which is when the sun is highest and burns the most. Which rays do you think are the most dangerous for the skin, infrared or ultraviolet? Why?

73. Color filters

Take a look at the simulation below and explain what happens when you place each of the three colour filters. Which light is deflected the most?



74. The red tomato

Explain why a tomato appears red when illuminated with white light. What colour would it look like when illuminated with a red light? And with green light?

75. White paint

When you want to paint a room that has few natural light, it is recommended to paint it white, because it is said to be a very bright colour. Why?

76. White towns

In Andalusia, towns with white houses are typical. Why do you think they have painted the houses with this colour and not with another? Are there white towns in Asturias? Why?

77. The colour of the clothes

The colour of an object is related to the light it reflects: it is red if it reflects red light, green if it reflects green, black if it absorbs all colours and reflects none, and white if it does not absorb any colour and reflects them all. Why do you wear light clothes in summer and dark in winter? What's wrong with black t-shirts in July?

78. The best and the worst lamp

Look at the previous images and select the ones that you consider the best and the worst street lighting lamp from the point of view of light pollution, making a drawing of each one of them.