TECHNOLOGY WORKBOOK

3º ESO

IES Dr. Antonio González González - Tejina

Student:_____ Course: 3rd ESO

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Class rules

- **Materials**: Students must have the following material available at **ALL**Technology classes:
  - The workbook. The exercise book.
  - Plastic covers (recommended) A
  - small ruler (recommended) A
  - number two pencil and an eraser.
  - Blue or black pen and another red one.
  - Pen Drive.
  - Scissors and a glue stick (recommended)
- **Class notebook**: Each student must have an exercise book. You should always write with a blue or black pen, except for drawings which will be done in a number two pencil. The date should always be on the header.
- **Always copy the statements**of the exercises that the teacher marks and keep your notebook tidy and clean.
- **The exercise book must always be up to date and available**In case your teacher asks for it, he/she will value that it is complete and organized.**NEVER THE LEAVE AT HOME.**
- **Photocopies**: If photocopies are provided, you must write your name and the date of delivery on them. Do not forget to include them in your workbook, inside a cover and in an orderly manner.
- **Internships and projects:**In the case of doing internships, it is necessary that the corresponding reports be delivered on the date established by the professor. As the course progresses, you will be given all the guidelines for preparing the reports,
- **You must be punctual**at the entrance to class. The number of late arrivals will be taken into account when evaluating. A student is considered late if he/she enters after the teacher closes the door.
- You must**respect the material**of the Department. The proper use of said material will be valued.
- Assignments must be submitted on the established date. If delivery is delayed by one day without justification,**goes down one point**. If the task is handed in early,**goes up one point**. If you are**is delayed more than a week, the homework is not collected and the student has a zero**.
- **You must respect the basic rules of coexistence**inside the classroom (ask for a turn to speak, do not get up without permission, when working in the workshop do so carefully, respecting the rules of coexistence and hygiene, work quietly in the computer room, etc.)

- The Department uses a service for students. It is a**Web page**where there are a multitude of resources for students (notes, exercises, links,...), as well as publishing news and notices. The blog address is ....

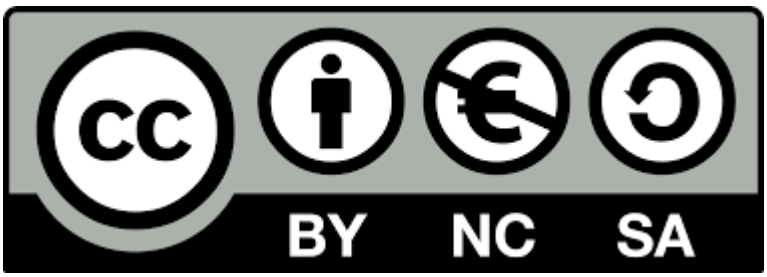
http://aprendemostecnologia.org

- Likewise, the Technology Department has a resource**Virtual Classroom**via the Internet, which is accessed with a password, which is personal and non-transferable. Some of the tasks will be done with the help of the Virtual Classroom if the teacher so decides. The address of the virtual classroom is...

https://www3.gobiernodecanarias.org/medusa/evagd/laguna/login/index.php

Your User is:

The password will be given to you by the teacher, so it is a good idea to memorize it.



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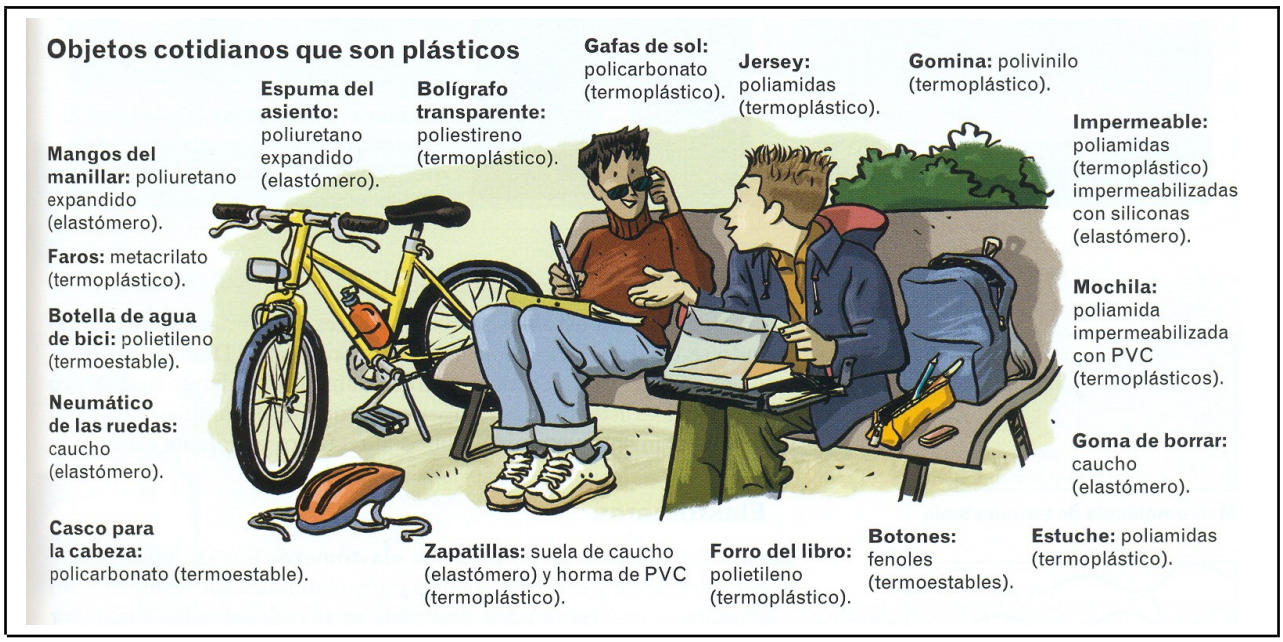
TOPIC 1: PLASTICS

1.1. INTRODUCTION

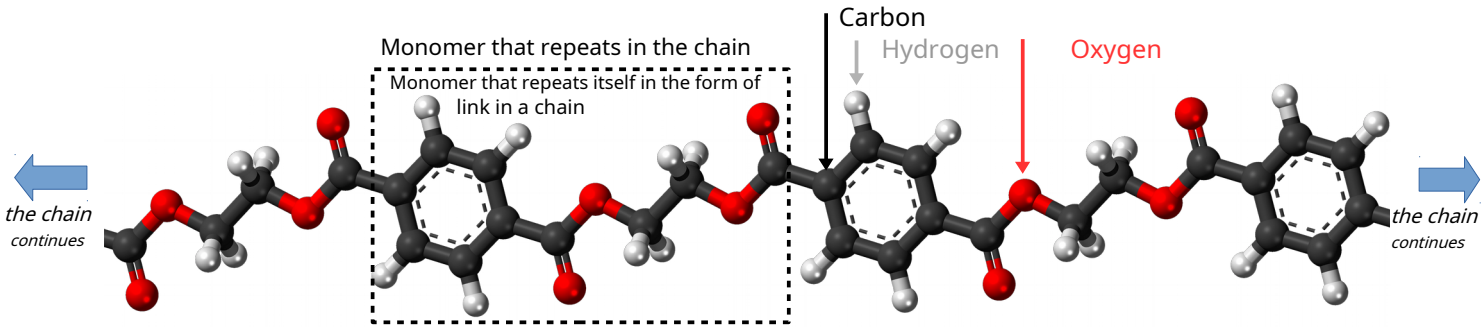
There are countless products all around us that are made entirely or partly from plastic. Nowadays, more than ever, plastic is present everywhere we go.



In general, a**plastic**It is a flexible, resistant, lightweight material that insulates electricity and heat. It is widely used in industry because it is easy to manufacture and mould, it is cheap, light and can be used with pigments of a wide variety of colours. In addition, it can be combined with other materials and thus improve their properties.

1.2. ORIGIN AND OBTAINING OF PLASTIC. POLYMERS.

The molecules of plastics are very long (they are**macromolecules**), forming a set of long chains that are entangled with each other. These molecular chains are composed of the union of basic units that are repeated like the links in a chain. These simpler molecules, linked together and repeated, are called**monomers.**The union of many monomers forms what is called a**polymer**, which is the other name by which plastics are known.



Molecular chain of PET, the polymer used to make water bottles. The PET chain is made up of basic units that repeat themselves, like links in a chain. Each link is a monomer and each monomer is made up of carbon, oxygen and hydrogen atoms. The union of many monomers forms polymers, that is, PLASTICS.

Although they exist**natural plastics**, like the**cellulose**and the**rubber**, the vast majority of plastics are materials**synthetics**They are obtained from raw materials such as**oil**, he**coal**or the **natural gas**. Although the vast majority are basically obtained from**oil.**

There are many**industrial methods**and complicated plastic manufacturing processes. The plastic material obtained can be shaped like**little balls**,**granules**either**powder**which are then processed and molded to convert them into sheets, tubes or final pieces of the object.

1.3. PROPERTIES OF PLASTICS

It is difficult to generalize about the properties of plastics due to the great variety of these that exist. Therefore, we will study the most significant ones, those that all of them share:

to)**Zero electrical conductivity**. Plastics conduct**bad electric current**, which is why they are used as electrical insulators; we see this, for example, in the coating of cables.

b)**Low thermal conductivity**Plastics tend to transmit heat very slowly, which is why they are often used as thermal insulators, for example, in the handles of cookware.

c) Plastics are usually materials**light**and have a low production cost (**economic**)

d)**Mechanical resistance.**For their light weight, plastics have good mechanical strength, meaning they can withstand compression, traction or bending forces without breaking down. This explains why they are used alongside metal alloys to build airplanes and why almost all toys are made of some type of plastic.

e) They tend to be**flexible**, although not all.

F)**Combustibility.**Most plastics**burns easily**, since their molecules are composed of carbon and hydrogen. The color of the flame and the smell of the smoke they give off are usually characteristic of each type of plastic. In addition, they do not withstand high temperatures.

g) Your**manufacturing techniques**They are simple**(easy to work with and shape)**and the ease with which they have to**combine**with other materials, making it possible to create composite materials with better properties, such as fiberglass-reinforced polyester.

h)**Great chemical resistance**: Most plastics are able to resist attack by many chemicals.

i) They are usually**raincoats**. It does not allow the passage of water and other liquids.

j) Most plastics can be**recycle**, but**No**are**biodegradable**.

1.4 TYPES OF PLASTICS: THERMOPLASTICS, THERMOSETS AND ELASTOMERS

1.4.1. THERMOPLASTICS

Thermoplastic plastics have the following**properties**:

a) They deform with heat and soften.
b) They can be molded and processed hot, acquiring the desired shape when cooled. This process can be done several times without losing their properties. That is, thermoplastics are**recyclable**.
c) They can melt at a certain temperature and solidify when cooled.

The maximum temperature to which they can be exposed does not exceed 150 ºC, except for Teflon, which is used as a coating on pots and pans.

NAME		PROPERTIES	APPLICATIONS
PVC (polyvinyl chloride)		It has a wide range of hardness. Waterproof.	Pipes, shoe soles, gloves, waterproof suits, hoses
Polystyrene (PS)	Hard	Transparent Pigmentable (can be colored with a pigment)	Transparent films for packaging and wrapping food products
	Expanded	Fluffy and soft	Packaging, wrapping, thermal and acoustic insulation.
Polyethylene (PE)	High density	Rigid and resistant. Transparent	Household utensils (buckets, containers, bottles, etc.) and toys
	Low density	Soft and light. Transparent.	Bags, sacks, glasses and plates.
Methacrylate(plexiglass)		Transparent	Car headlights and taillights, windows, illuminated signs, clocks.
Teflon(fluorocarbon)		Sliding Non-stick	Cookware, such as pans and countertop surfaces
Cellophane		Transparent (with or without color). Flexible and resistant. Bright and adherent.	Packaging, packing and packaging.
Nylon(PA or polyamide)		Translucent, shiny, any color. Strong, flexible and waterproof.	Fabrics, toothbrushes, racket strings.

1.4.2. THERMOSTABLE

a) Plastics**thermosetting,**When you heat them for the first time, they soften and can be shape under pressure and heat, this process is called**cured**. If heat is applied to them again, they degrade, which is why they can only be heated and shaped once.

b) During this process, the polymer chains cross-link, giving a plastic**further hard, rigid and temperature resistant than thermoplastics**, but**more fragile**at the same time.

c) They cannot be melted or recycled by heat since, once cured, they cannot be molded or processed again.

NAME	PROPERTIES	APPLICATIONS
Polyurethane (PUR)	Fluffy and flexible. Soft and solid. Elastic and adherent.	Foam for mattresses and seats, sponges, thermal and acoustic insulation, gaskets, belts for movement transmission, friction wheels, glues and varnishes.
Resins phenolic (PH): **bakelites**	With fibers, resistant to shock. With asbestos, heat resistant. Black or very dark colour. Electrical insulators.	Handles of kitchen utensils, gear wheels, housings of household appliances, vacuum cleaners or switches, ashtrays.
Melamine	Light. Strong and of considerable hardness. It has no smell or taste. Thermal insulation.	Electrical accessories, thermal and acoustic insulation, kitchen worktop surfaces, tableware, food containers.

1.4.3. ELASTOMERS

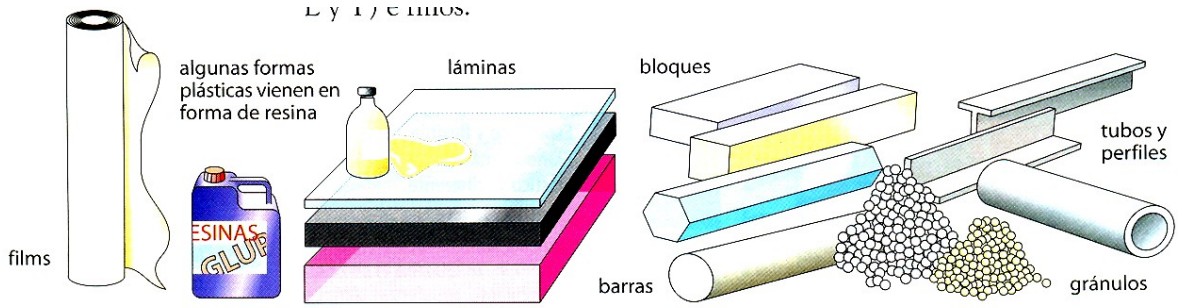
The macromolecules of plastics**elastomers**They form a network that can contract and stretch when these materials are compressed or stretched, so these types of plastics are very**elastics**.

They do not withstand heat well and degrade at medium temperatures, which causes*heat recycling is not possible*.

GUYS	OBTAINING	PROPERTIES	APPLICATIONS
Rubber natural	Latex	• Resistant. • Inert.	Thermal and electrical insulation
Rubber synthetic	Derivatives of oil	• Resistant to chemical agents.	Tires, steering wheels, bumpers, pavements, pipes, hoses, bath sponges, gloves and mattresses.
Neoprene	Rubber synthetic	• Improves the properties of synthetic rubber: it is harder and more resistant. • Waterproof.	Immersion suits.

1.5. PLASTIC MATERIAL PROCESSING. MANUFACTURING OBJECTS. Most plastics are derived from petroleum, but not all.

From various forms such as granules, sheets or balls of plastic material, different techniques are followed to manufacture an object. Manufacturing a plastic object is**shape**plastic.



Formas en las que se presentan los materiales plásticos para su conformación.

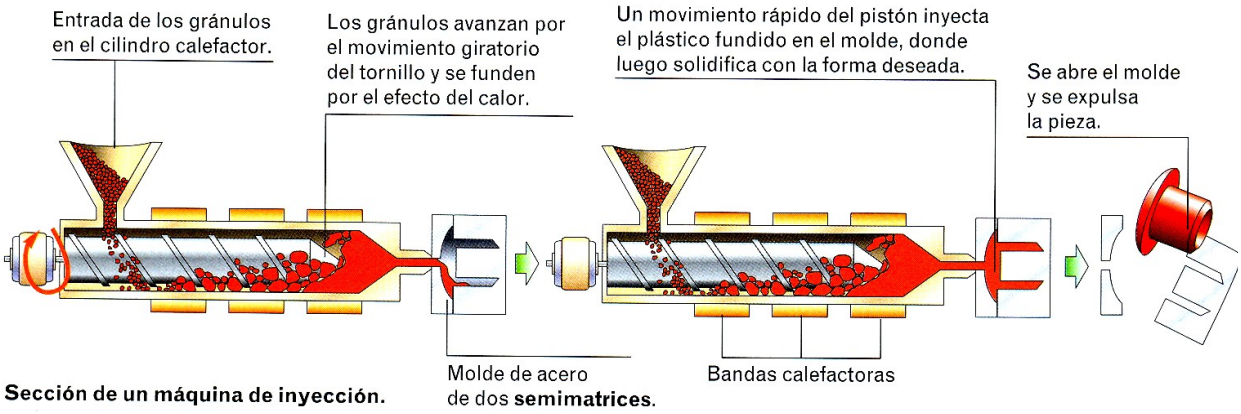
All the techniques have in common that it is necessary heat the plastic and insert it into a mold The difference between each of the processing techniques is in the way of shaping the polymer.

Let's look at some of the following plastic forming techniques:

1. Injection molding
2. Extrusion
3. Blow molding
4. Compression molding
5. Spinning
6. Laminate
7. Foaming
8. Vacuum molding

INJECTION MOLDING

Let's follow the manufacturing process by looking at the illustration.



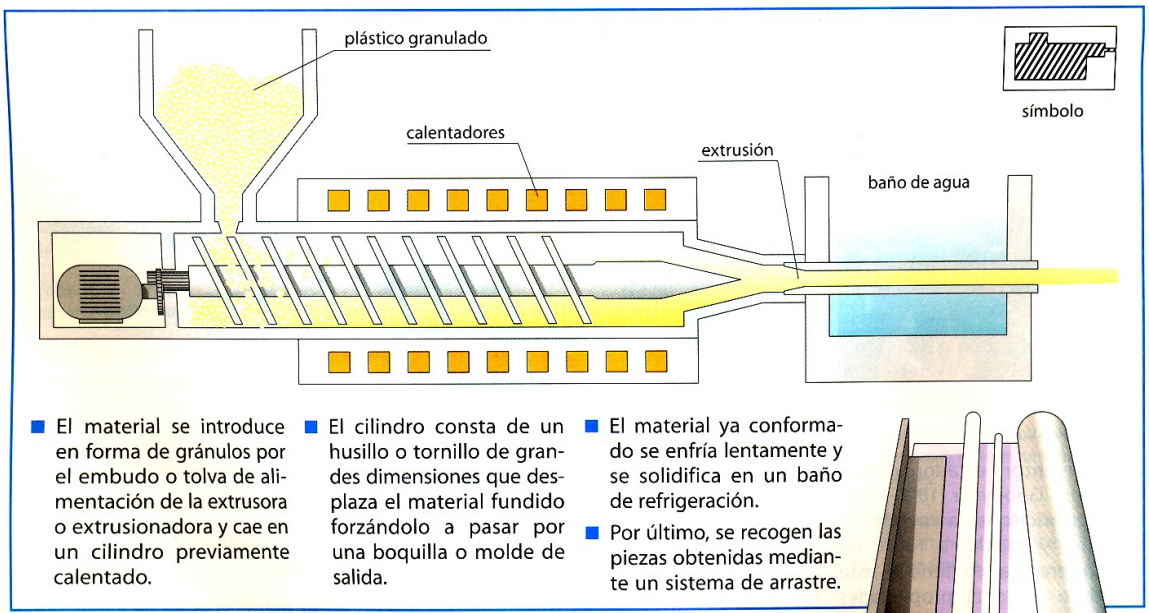
Sección de un máquina de inyección.

As we can see, it consists of injecting the thermoplastic material that has been previously melted into a mould; when the material cools and solidifies, the mould is opened and the piece is removed.

This process is used to make household utensils (buckets, containers, plates, etc.), object casings, toys, etc.

EXTRUSION

A pastry bag for decorating cakes is a simple extrusion machine. Depending on the nozzle of the bag, the cream will have a certain shape and thickness. In the plastics industry, extrusion is also used to make, for example, a pen, where we need two tubes: a hexagonal one for the casing and a round one for the ink.

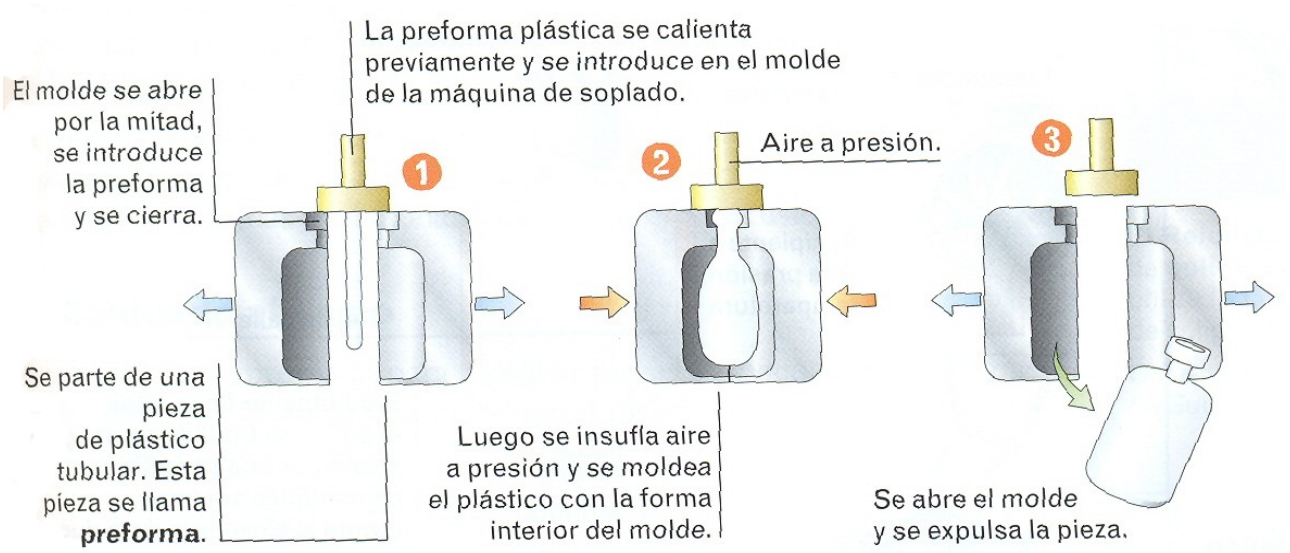


Aplicaciones: filmes para embalaje, perfiles para rematar obras, recubrimiento aislante para cables eléctricos y tubos para cañerías y tuberías.

BLOW MOLDING

By the method of**blown**, we introduce the hot plastic material in the form of a tube into a mold that closes when the tube has the desired size; then pressurized air is introduced, causing the plastic tube to adapt to the walls of the mold and take its shape; after cooling, the mold is opened and the object is removed.

It is used to make hollow objects such as oil and mineral water bottles, jars and some toys (such as balls), etc.



1.6 THE ENVIRONMENTAL IMPACT OF PLASTICS

Plastics made from fossil fuels appeared just over a century ago, although their use became widespread after the Second World War (just over 70 years ago). Therefore, their widespread use can be said to be recent. In their day, they came to stay, since they have made our lives easier, creating a new concept: “the disposable life”.

However, its production has created a far-reaching environmental problem, since during the first 15 years of the 21st century the same amount of plastic has been generated as during the entire 20th century, and if things continue in the same way, the problem may not be reversible.

Why is the accumulation of plastics so serious?

1. They take up a lot of volume in relation to their weight.

2. The time it takes to decompose, compared to other products, is much longer. If we compare it with other materials, we can see that:

   Organic and plant products decompose within 3 to 4 weeks. Aluminum takes approximately 350 to 400 years;

   Plastics last an average of 500 years. They are not biodegradable.

   That is to say: unlike other waste,*Plastics are not biodegradable, as they do not decompose or rot in water, so they remain in landfills without disappearing for centuries.*

   Due to these two factors, a large amount of plastic has accumulated in all oceans, affecting more than 700 species of animals and ending up passing to humans through the food chain.

1.6.1 OCEANS OF PLASTICS

Every year, about 8 million tons of plastic are dumped into the ocean. Most of it is thrown onto the ground and reaches the sea via rivers, wind or rainwater. To give you an idea, that amount of plastic is equivalent to 15 full shopping bags for every meter of coastline on the entire planet. This plastic will take centuries to decompose, but before it decomposes it will become**microplastics**.

Microplastics are**fragments**of plastics of**less than 5 mm**The microplastics are formed from the millions of tons of waste that reach the oceans. The waste is transformed into microplastics by the sun, wind and waves. Plankton, fish, turtles, seabirds and even whales mistake these pieces for food and cause intestinal obstructions. The animals stop eating and die.

It is estimated that one in three species of fish eaten by humans contains microplastics.

This albatross has died from ingesting large amounts of plastic that it mistook for food

1.6.2 A SOLUTION: PLASTIC RECYCLING

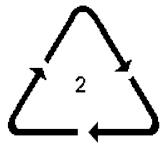
Due to the great impact of plastics on the environment, the methods of eliminating these wastes must involve other solutions than throwing them into a landfill, such as, for example, their recovery, either to create new objects (**recycling**), to generate**electrical energy**or to obtain fuel (**cracking**).

And the first big challenge is its**selective collection**; that is, citizens must separate them from the rest of the rubbish and deposit them in the appropriate container (which we all know is the yellow one). This requires everyone's collaboration, because this first step is essential.

1.6.3. HOW PLASTIC IS RECYCLED

Although the amount of plastic waste generated is enormous, only**six plastics** They make up 90% of waste. Therefore, almost the entire recycling industry is focused on the recovery of these six types, which happen to be thermoplastics.

The**ID**of recyclable plastic packaging is easily achieved by looking at the number, or the initials, of the American identification system**SPI**(*Society of Plastics Industry*), which usually appears on the bottom of some plastic objects, where you can see a triangle like the one in the figure. Inside it there is a number and at the bottom of it some initials. Both the number and the initials refer to the chemical composition of the plastic. In general, the lower the number, the higher the initials. the easier it is to recycle. Thus, once it has been produced,**selective collection**, to recycle plastic you first have to**classify it**according to their number, because each of the plastic categories are incompatible with each other and cannot be recycled together.

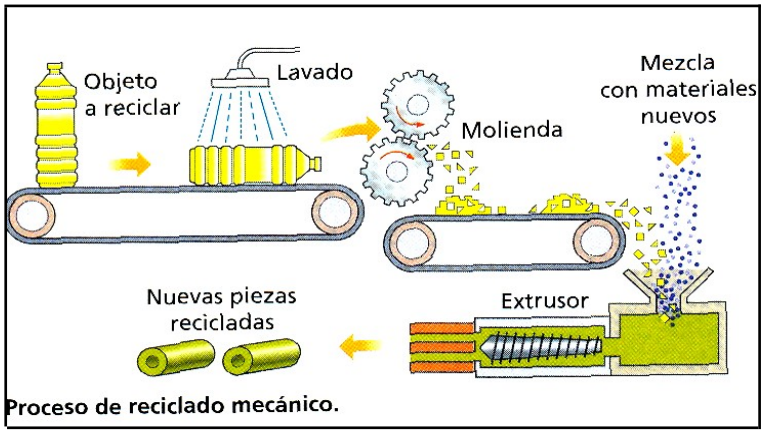


1.6.4. PLASTIC RECYCLING PROCESSES

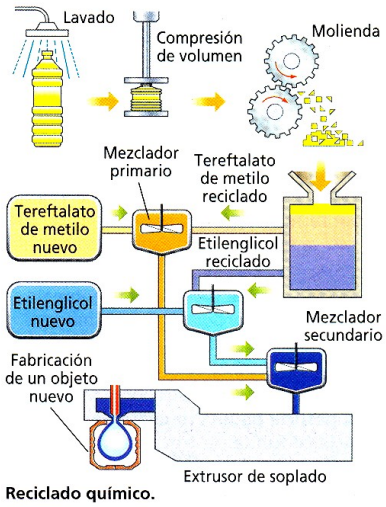
Once the plastics have been separated and classified according to the type of thermoplastic, they are recycled. There are three different methods depending on the use that will be given to the plastic, something that we already mentioned before; let's look at them now in a little more detail.

MECHANICAL RECYCLING

It basically consists of washing crushing the plastic and applying heat and pressure to the objects to give them a new shape, thus obtaining new plastic objects. It can only be applied, as you may know, to thermoplastics, which melt when heated.



Proceso de reciclado mecánico.



Reciclado químico.

CHEMICAL RECYCLING

It consists of mixing crushed plastic waste with a series of chemical substances that dissolve it.

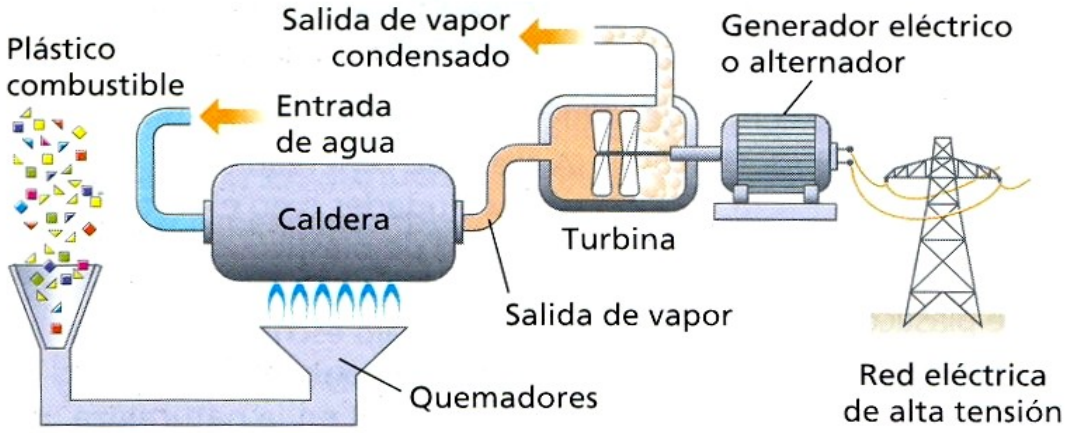
In this way, the chemical components of the plastic are separated (breaking down the molecules) into the monomers that form it, reversing the steps that were followed to create them.

Once the monomers are obtained, they are recombined to form new plastics.

It is a more expensive method, but it allows obtaining purer and better quality plastics.

ENERGY RECYCLING

Many plastics can burn and serve as fuel. For example, one kilogram of polypropylene provides almost three times more heat energy when burned than one kilogram of wood. But since this is a combustion process, CO is generated.$_2$which is released into the atmosphere and contributes to the greenhouse effect, as well as other gaseous compounds that can be toxic. Therefore, the process must be accompanied by controls and safety measures to prevent harmful effects.



Reciclado energético. El plástico combustible genera la energía suficiente para que una caldera caliente agua y genere vapor. Dicho vapor entra en una turbina y mueve el eje de un alternador, mediante el cual se genera electricidad.

1.6.5 WHAT CAN YOU DO?

- **Don't use plastic bags**: Bring your own reusable bags to shops and supermarkets when you go shopping. Tell your parents to always carry them in the car. Since July 1, 2018, all shops are required to charge for them.
- **Drink soft drinks and juices without a straw**Paper straws are already being manufactured.
- **No plastic bottles.**Use refillable water bottles.
- **Avoid buying products that come in plastic packaging**. Buy in bulk. Avoid buying fruit, vegetables or sausages that come packaged in plastic.
- **Recycle everything you can**: Separate all plastic containers in a container and throw them in the yellow container. Only 18% of plastic waste is recycled worldwide and only together can we increase this percentage.
- **Don't throw garbage into nature**: If you go to the beach or the mountains, collect all your waste and then separate it. 73% of the rubbish on the beaches is plastic. The street is also your environment. Use the bins and if you see a recycling container, all the better.

PLASTIC EXERCISES: PART I

1. Explain the difference between a natural, an artificial and a synthetic material. of each. Indicate to which of the three groups plastics belong. Give an example
2. What is a plastic? What raw material are most of them obtained from?
3. Materials for technical use can be divided into three large groups: raw materials, processed materials and processed products.
   a) What are raw materials? Give an example.
   b) What are manufactured materials? Name an example.
   c) What are manufactured products? Name an example.
   d) What type of technical materials are plastics among the three main groups?
4. Define the following words related to plastics:
   a) macromolecule
   b) polymer
   c) elastomer
   d) extrusion
5. Make a list with 5general characteristics that plastic materials have.
6. Ecological properties that plastics can have
7. Explain in your own words why it is said that a plastic is*versatile*.
8. There are three groups of plastics: thermoplastics, thermosets and elastomers. Explain the characteristics of each. Which of the three has the greatest abundance of plastics? Which can be recycled?
9. Thermosets are harder and, at the same time, more brittle than thermoplastics. What does this mean?
10. (*) Classifies the following plastics, indicate some of their properties and an example of their use:

Plastic	**Guy**	**Property**(Indicates the most important of the plastic)	**Application**
Nylon			
Polystyrene			
Rubber natural			
Cellophane			
PVC			
Polyurethane			
Methacrylate			
Rubber synthetic			
Melamine			

PLASTIC EXERCISES: PART II

1. Explain extrusion molding. Four examples of objects manufactured using this method

2. Explain blow molding. Give three examples of objects manufactured using the blow molding method.

3. Explain injection molding. List four objects manufactured using the injection method.

4.**(*)**Indicate which processing system was used to manufacture the following objects.

a) bottle
b) electrical device
c) plastic tablecloth
d) roll of transparent film
e) pipe
f) plastic bag

5.**(*)**Complete the following table. Some of them you have to research on the Internet.

Name of the plastic	**Type of plastic**
Rubber	
Polyvinyl chloride	
Phenols (Bakelite)	
Porexpan (white cork)	
Methacrylates	
Polycarbonates	
Polystyrene	
High density polyethylene	
Low density polyethylene	
Polyethylene terephthalate (PET)	
Polypropylene	
Polyurethane	
Epoxy resins	
Silicones	
Teflon	

PLASTICS EXERCISES: PART III

1.**(*)**Mark with an X the properties that most plastics generally have.

	Light		They burn easily		Conducts heat
	Heavy		It is a durable material		Does not conduct heat
	Low mechanical resistance		Permeable		They admit a variety of colors
	Good mechanical resistance		Raincoats		Heavy
	Rigid		Expensive		Economical
	Recyclables		Renewables		Biodegradable
	They do not allow a variety of colors		They can be combined with other materials		It is a material that lasts a short time.
	They cannot be combined with other materials		Machinable (easy to working with machines)		They resist temperatures very high
	High resistance to chemical attack		Conduct the current electric		They do not resist high temperatures

2. How long does it take for plastic to degrade? What are the consequences for the environment?

3. Explain what microplastics are and how they affect the environment.

4. Instead of throwing plastics into landfills, what can be done with them? Explain each of the things that can be done to avoid the environmental impact of plastics.

5.**(*)**What does selective plastic collection consist of?

What color is the plastic container container?

6.**(*)**There are six types of plastic that account for 90% of those that can be recycled.

a) How can a person identify them to see if they can be recycled?

b) Indicate which are those six plastics

c) If the identification number of the recyclable plastic is low, what does this mean?

7.**(*)**Indicate the type of thermosetting material from which the following objects can be made, and also indicate what properties that plastic has.

Plastic object	**Name of the plastic**	**Properties**
Handle of a coffee maker		
Kitchen stand (plastic)		
Car seat		
Sound insulation		
Switch		
TV housing		

8.**(*)**Indicate the type of thermoplastics from which the following objects can be made. It also indicates which properties of the plastic have been chosen to manufacture the object.

Plastic object	**Name of the plastic**	**Properties (indicate at least two)**
Mop bucket		
Strings of a tennis racket		
The bottom of the pan		
Plastic wrap (transparent film)		
Pipes for water		
Car headlights		
The white cork that serves as packaging for a TV		
Socks		
Water bottle		
Hose		
Toys		
Grocery bag		
Windows (plastic)		
Toys		
Waterproof		
The mortadella packaging tray		

9. **(*)** Fill in the following table. In the left column indicate the 3 methods of recycling plastics and in the right column indicate what they consist of.

Recycling method	**What does it consist of?**

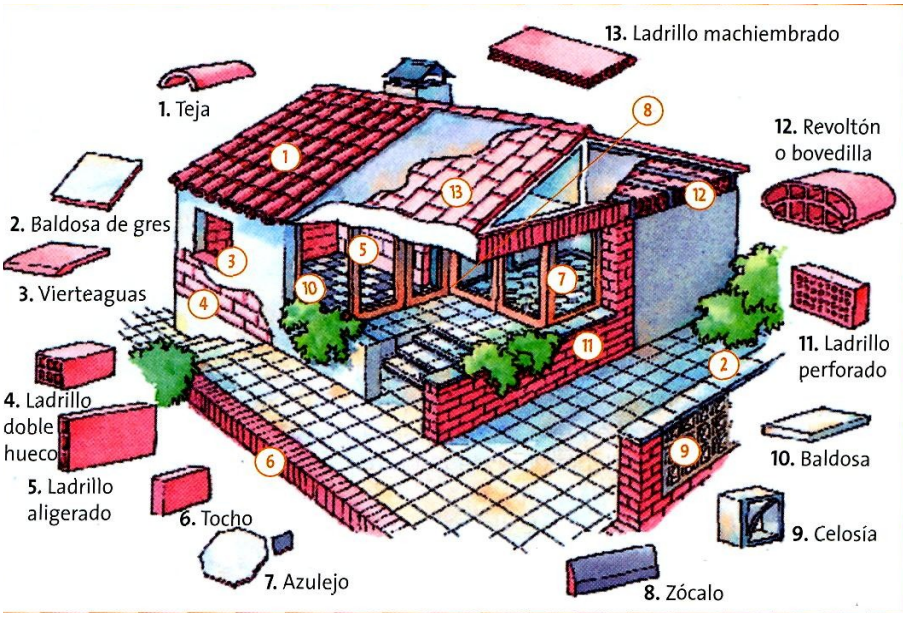
10. (*) The energy recycling of plastics has a major drawback. What is it? What advantages does it have?

STONE AND CERAMIC MATERIALS

1. STONE MATERIALS

Stone materials arenatural stones They are obtained from rocks and are used with hardly any transformations, mainly in the construction of buildings, public works and for ornamentation.

They can be presented in the form of blocks or tiles (marble, granite and slate), or also in the form of large



2.SUBJECT

We call**binder**a material that is used to join other materials.

The binders used in construction are materials that, once mixed with water, have the property of hardening (**forge**), which is why they are widely used in construction to form part of structures, join ceramic materials, plaster exteriors, etc.

Its raw materials are the sand and gravel that are used, especially fragmented, to generate this type of materials so widely used in construction: plaster, cement and lime.

Other materials that we include among the binders due to their characteristics, although they are compounds, are:

to)**The mortar**: mixture of sand and cement used to bind blocks or stones together; also used for plastering.

Mortar for joining bricks

b)**Concrete**: a mixture of gravel, sand, water and cement that hardens over time; it is economical, durable, fire-resistant and can be manufactured directly on site. Although it is highly resistant to compression, its main problem is its low tensile strength.

c)**Reinforced concrete**: Iron or steel bars are introduced into the concrete before it sets, to improve its tensile and flexural strength.

3. CERAMIC MATERIALS

Ceramic materials are obtained from clay raw materials. Clay is**molds**and undergoes a process of **cooking in an oven at high temperatures**. Depending on the nature and treatment of the raw materials, two large groups are distinguished: ceramics **fine**and ceramics**thick**(permeable).

- **Thick ceramics:**The material has not undergone vitrification, that is, the clay has not melted or taken on the appearance of glass after being fired at relatively low temperatures in the kiln. When the coarse ceramic is fractured, it has an earthy appearance (example: tile).
- **Fine ceramics:**The material has undergone vitrification, as the clay melted and took on the appearance of glass after being fired at high temperatures in the oven.

	MATERIALES	PROPIEDADES	APLICACIONES
Cerámicas gruesas	**Arcilla cocida** (se obtiene a partir de arcilla ordinaria de color rojizo mate)	- Tacto duro y áspero - Frágil 	Puede aparecer recubierta o no de un esmalte blanco: ladrillos, tejas, otros elementos de construcción, objetos de alfarería (vasijas, recipientes, jarrones, macetas, botijos…)
	Loza (se obtiene a partir de una mezcla de arcilla amarilla y arena)	- Tacto fino y suave - Elevada dureza	 Cubierta por una capa de barniz o de esmalte, que le proporciona un atractivo aspecto superficial: vajillas y objetos decorativos.
	Refractarios (formados por arcilla cocida con óxidos de metales)	- Resistentes a temperaturas superiores a 3.000ºC	Revestimiento interior de altos hornos, chimeneas, componentes eléctricos y electrónicos. 
Cerámicas finas	**Gres** (compuesta por arcillas refractarias y sal)	- Aspecto vidriado - Elevada dureza (raya al vidrio) - Gran compatibilidad - Sonido metálico por percusión.	Baldosas, azulejos, tubos, ladrillos, etc. 
	Porcelana (se obtiene de arcilla blanca muy seleccionada)	- Transparente o translúcida - Compacta - Sonido metálico por percusión. - Elevada dureza (no es rayada por el acero). - Resistente a los ácidos.	 Con un grosor entre 2-3 mm., vajillas, objetos decorativos, aislantes eléctricos, sanitarios, industria química…

Problems of stone materials

1. Answer the following questions:

a) How are ceramic materials made?

b) What is porcelain?

c) What materials make up the mortar?

2. What is the difference between concrete and reinforced concrete?

3. Briefly explain in your own words what cement setting means.

4.**(*)**Make a list of eight objects made using stone materials; indicate what material they are made of.

OBJECT	APPLICATION	OBJECT	APPLICATION

5.**(*)**Complete the following table indicating in each case the material from which the mentioned objects are made or what type of objects we can make with the materials we indicate.

MATERIAL	APLICACIÓN	MATERIAL	APLICACIÓN
Granito		Mármol	
	Industria eléctrica		Molduras
Vidrio refractario		Cemento	
	Oftalmología	Arcilla	
Arena			Tejas

6.**(*)**Make a list of the materials you have studied that are present in different rooms of a home. Pay attention to the walls, the floor and the ceiling.

a) Kitchen

b) Bathroom

c) Living room

7.**(*)**Name eight materials needed to construct a building.

8.**(*)**Match the materials with their applications:

A. Caliza	**1.** Se usa para fabricar cemento.		
B. Granito	**2.** Pavimentación de exteriores.		
C. Mármol	**3.** Cubierta de suelos y paredes interiores.		
D. Pizarra	**4.** Cubiertas de tejados.		
E. Áridos	**5.** Componente de relleno de hormigones.		

TOPIC 2 - ENERGY

We have all always known the concept of energy. However, there is a notable difference between the popular idea of 'energy' and that of science and technology. In fact, we intuit that if "something" has or provides energy, we think that it is capable of producing some effect in its environment, whether it is moving something, or producing heat, or being a source of light... The fact is that energy creates CHANGE and TRANSFORMATIONS in the environment.

1. CONCEPT OF ENERGY

Energy is a property associated with matter, and in physics it is defined as follows:

Energy is the capacity of a body to do work.

Activity When we run we use our energy to do work. Put four examples that occur to you of energy use.

2. TYPES OR FORMS OF ENERGY

Energy can manifest itself in nature in different forms that can, in turn, be transformed into another type of energy. Some of the simplest forms of energy appear below:

1. **Mechanical Energy:** is that which bodies possess due to their movement (an engine, for example). There are two types of mechanical energy: potential and kinetic.**potential energy**is what bodies have due to their position, and the**kinetic energy**the one they have due to their speed. Thus, for example, water in a glass placed one metre high has potential energy, since if I spill it, that water will be able to do some work when it reaches the ground, such as dragging sand from the ground.
2. **Thermal Energy:** It is the energy associated with the heat that a body can absorb or give off. So when we heat water, we are transferring thermal energy to it. A body at a low temperature will have less thermal energy than one at a higher temperature.
3. **Chemical Energy:** Chemical energy is the energy stored within chemical products. Fuels such as wood, coal, and oil are clear examples of energy stored in chemical form. It is also the energy produced in chemical reactions. It is transformed into other forms of energy when chemical reactions such as combustion occur. For example, when we burn coal we extract the energy that links atoms with others and release it in the form of heat. Chemical energy is the type of energy that batteries also store.
4. **Light Energy:** It is the energy transmitted by means of electromagnetic waves. A particular case is the light energy emitted by the sun. X-rays are also considered as such. It could be said that X-rays, infrared, ultraviolet are “invisible” light.
5. **Sound Energy:** It is the one that carries sound.
6. **Electrical energy:** It is the energy possessed by moving electric charges through conductive materials. Due to its capacity to transform into other forms of energy, it is suitable for many machines.
7. **Nuclear power:** is contained in the nuclei of atoms.

3. PRINCIPLE OF CONSERVATION OF ENERGY

You have no doubt heard phrases like “it has no more energy” or “it is running out of energy”; however, from a physics point of view, this is incorrect. What is happening is simply that the initial form of energy has been transformed into another type of energy that we can no longer use.

Adding an example to those in the previous section, if we think about fireworks, gunpowder contains chemical energy that is transformed into kinetic energy (it moves), potential energy (because it reaches a height), sound energy, light energy and heat energy,keeping the total energy constant .

Energy is neither created nor destroyed, it only transforms.

4. ENERGY TRANSFORMATIONS

As we have just seen, there are many forms of energy, and all the phenomena that occur in nature (the formation of clouds, wind, rain, the existence of life, etc.) are a consequence of the passage of energy from some bodies to others and their transformation.

Energy can be transformed from one type to another. Look at the following table:

APPARATUS	INITIAL ENERGY	FINAL ENERGY
Electric motor	Electric	Mechanics
Combustion engine	Chemistry	Mechanics
Electric stove	Electric	Thermal
Gas cooker	Chemistry	Thermal
Lamp	Electric	Luminous
Speaker	Electric	Sonora
Solar panel	Luminous	Electric
Stack	Chemistry	Electric
Thermal power station	Chemistry	Electric
brake shoe	Mechanics	Thermal

5. ENERGY MEASUREMENT

The energy possessed by a body cannot be measured directly, but the work done with it can. For this reason, the units in which energy is measured are the same as those for work.

In the International System, work and energy are measured in**Joules**(J), but depending on the form of energy, other units are also used:

Form of energy	Units
Electrical energy	Kilowatt - hour (**kWh**)
Heat and chemical energy	Calorie (**lime**) or Kilocalorie (**Kcal**)

6. ENERGY SOURCES

In order to use any form of energy, we will have to find a natural phenomenon or create an artificial system that has the appropriate technology to be able to use said energy. That is, we will have to find a**energy source**.

Energy sources	Form of energy that contains
Oil, gas natural or coal	Chemical energy. This energy is released by combustion (burning it).
Uranium 235	Nuclear energy, stored in the nuclei of uranium 235 atoms
Wind	Mechanical kinetic energy that the wind possesses.
Solar	Light energy that sunlight possesses
Biomass	pruning, biofuels, etc.).
Hydraulics	Potential mechanical energy stored in the water of a reservoir.
Geothermal	Thermal energy that is stored inside the earth's crust.

The amount of energy available from a given energy source is called **energy resource**.

The scarcity of energy resources (oil, coal and wood) in some of the most widely used energy sources raises the need to use other sources and investigate the most profitable way to use them.

7. CLASSIFICATION OF ENERGY SOURCES

Depending on the criteria we adopt, we can classify energy sources in several ways:

CRITERION	CLASSIFICATION	DESCRIPTION
Considering your availability in nature and its ability to regeneration	**Renewables**	Abundant and inexhaustible sources of energy in nature
	Non-renewable	They may or may not be abundant in nature, but they are depleted when used and are not renewed in the short term, since they need millions of years to be formed again. They are the most widely used today.
Considering your use in each country	**Conventional**	They are the most widely used in industrialized countries, such as energy from fossil fuels; they are important in the economies of these countries.
	No conventional or alternatives	They are alternative sources of energy that are just beginning their technological development.
Considering your impact environmental	**Clean or not pollutants**	They are sources whose extraction produces minimal environmental impact; in addition, they do not generate toxic or polluting by-products.
	Pollutants	These are sources that produce negative effects on the environment, some due to the way they are obtained (mines, construction, logging, etc.); others at the time of their use (fuel in general); and some produce highly polluting by-products (nuclear waste).

Look at the following table where the different energy sources are classified according to the above criteria:

Source of energy	Capacity of regeneration		Current importance		Environmental impact	
	Renewable	No Renewable	Conventional	No Conventional	Clean	Pollutant
Hydraulics						
Geothermal						
Nuclear						
Wind						
Solar						
Oil and derivatives						
Coal						
Natural gas						
Biomass						

8. ELECTRICAL ENERGY

8.1. ELECTRICAL CURRENT

Electric current is the movement of electrons through a conductor. There are two types of current:

1. **DC:** Electrons move in the same direction and their value is constant over time. Examples of direct current generators are batteries and, in general, any generator that has two poles (positive and negative). Electronic devices usually use this type of current (mobile phones, laptops, tablets, watches, etc.) and in general any device that uses batteries.

2. **AC:** Electrons constantly change direction (50 times in one second) and their value is not constant over time. This is the energy that reaches our homes and is generated by most power stations. Any appliance that you connect to a power socket in your home and does not have an adapter consumes alternating current (washing machine, blender, vacuum cleaner, etc.)

8.2. CONCEPT OF ELECTRICAL ENERGY

As we saw at the beginning,**Electrical energy is that transported by electric current.**

It is the most widely used form of energy in industrialized societies. If you look around you, you will see a multitude of objects that use electrical energy to operate. This is due to these two characteristics:

- Ability to be easily transformed into other forms of energy (light: light bulbs; heat: stoves; mechanical: electric motor, etc.).
- It can be transported over long distances at low cost, quickly and with relatively high performance (excessive energy is not lost).

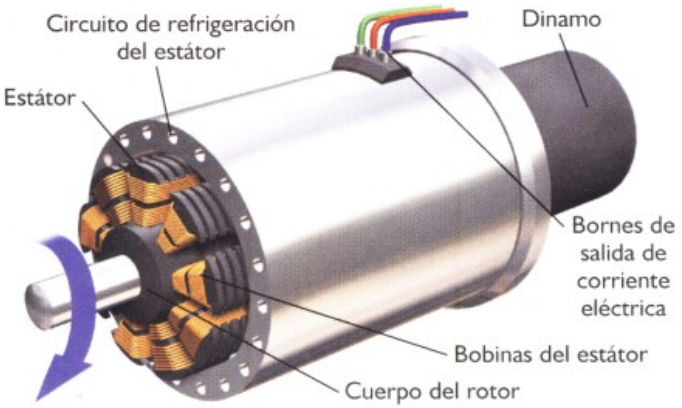
The human being has created the**power plants**: facilities where some of the energy sources are transformed into electrical energy.

Once generated, this energy for consumption must be transported to the points where it is needed. Once there, it will be distributed: homes, street lighting, industries, etc.

8.3. ELECTRICAL ENERGY PRODUCTION

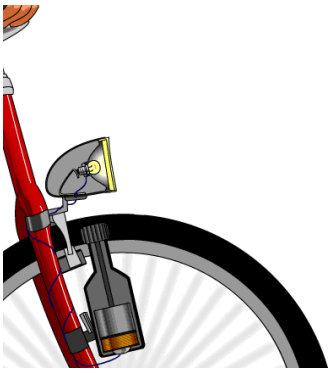
ALTERNATORS

The machine responsible for generating alternating current in a power plant is called **electric generator or alternator**. It has two parts, one that moves (**rotor**) and another that is fixed (**stator**). The rotor needs to move for current to be produced, otherwise it would not work.



Schematic of an alternator

In most power plants, alternators are moved with the help of an element coupled to the rotor shaft:**the turbine**The turbine can be moved in different ways (wind, a waterfall, a jet of water vapor, etc.).



For example: a bicycle dynamo is a type of electrical generator in which the movement of the rotor, when it rubs against the wheel, generates the electrical energy needed to turn on the headlight.

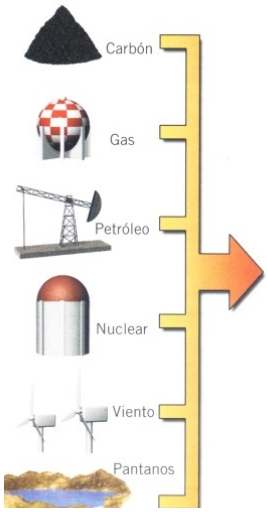
8.4. TYPES OF POWER PLANTS

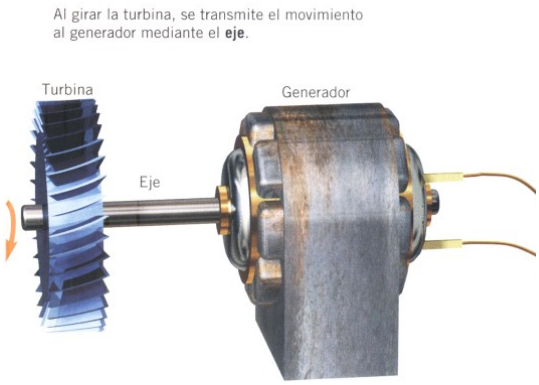
Although electrical phenomena were already known in ancient times, it was not until the 19th century that methods were devised to generate electric current.

The problem of generating electrical energy was solved with the appearance of facilities capable of producing electrical energy on a large scale:**power plants**.

There are various types of power plants, which are determined by the source of energy they use to move the rotor of an alternator. They all have the following in common. In all of them, it is a matter of making a turbine turn, which in turn makes the rotor of the alternator turn to generate electrical energy. Most of the plants are conventional, using the heat generated by the alternators.

fuels to drive the turbine.





Among non-conventional energies, solar and wind energy are the ones that have the greatest impact. are currently being implemented, but the use of other renewable energies, such as ocean energy, is being experimented with, in addition to the use of organic waste as a source of energy (biomass).

The main types of power plants are as follows:

1. **Thermal power plants:** produce electricity from the chemical energy stored in a fuel (coal, petroleum derivatives, etc.)

2. **Hydroelectric power plants:** They produce electricity from the mechanical energy of water stored in a reservoir.

3. **Nuclear power plants:** produce electricity from the energy stored in the core of the atom. Uranium and plutonium atoms are used.

4. **Solar power plants:** They transform light energy from the Sun into electrical energy. There are two types: thermal and photovoltaic.

5. **Wind power plants :**They produce electricity from wind energy.

6. **Geothermal power plants** : They produce electricity from the thermal energy stored in the interior of the earth's crust.

7. **Biomass power plants** : they produce electrical energy from biomass.

We will analyse the first five cases, as they represent almost all of the energy production in Spain. In the case of solar energy, we will focus on photovoltaic solar energy.

THERMAL POWER PLANT

This is the most important type of power station in the Canary Islands. There is one of these power stations on each smaller island, and there are two on each of the larger islands. In Tenerife, the oldest one is in Las Caletillas and the other in Granadilla. Almost 93% of the energy produced in the Canary Islands is through thermal power stations that use fossil fuels. This gives you an idea of the great dependence of the Canary Islands on foreign countries, as we do not produce oil or coal.

As these are the most important power plants in the production of electricity in our archipelago, we are going to study them in detail. Let's look at the image we have:

- In a boiler, we burn fuel (chemical energy) which is usually a fossil fuel, garbage, biomass, etc.In the Canary Islands it is a derivative of petroleum (fuel and diesel) .
- The heat of combustion is used to transform water into steam, which also has a greatly increased pressure (thermal energy).
- We release the pressurized water vapor and it is directed to the turbine, whose shaft is connected to the alternator rotor shaft (kinetic energy).
- If the rotor moves, it produceselectrical energy in the form of alternating current.
- The water vapor, once used, is cooled (chilled) in the cooling tower and transformed back into liquid water, then passing to a tank to be sent back to the boiler and start the cycle again.
- The electrical energy as it is obtained must pass through a transformer to raise the voltage very much, lowering the current intensity. That is why this electrical network is calledhigh voltage .

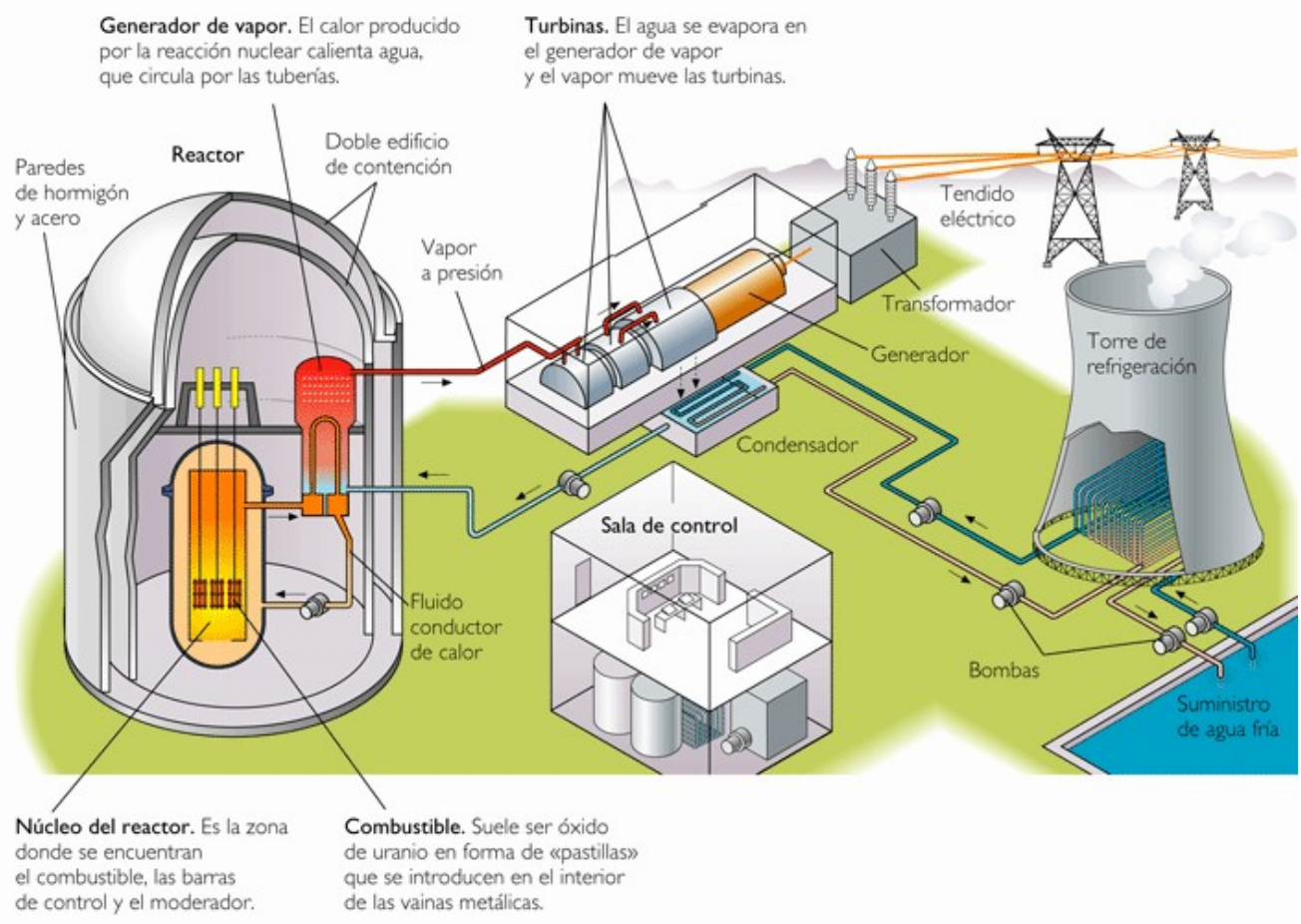
That is, the energy changes that occur in the thermal power plant are:

Chemical energy → Thermal energy → Kinetic energy → Electrical energy

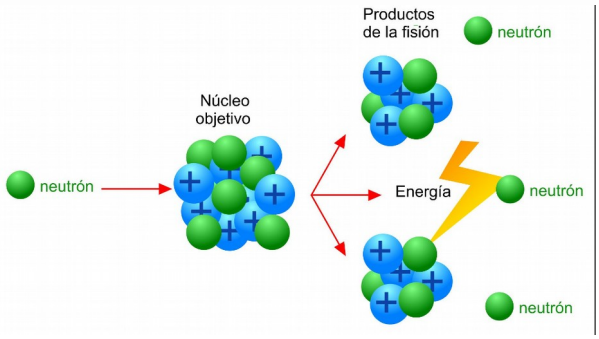
NUCLEAR POWER STATION

In Spain there are 6 nuclear power plants in operation (none in the Canary Islands) that produce about 20% of all the energy in the country, while there are 62 thermal power plants that produce about 30%. This gives us an idea of the power and efficiency of nuclear power plants.

Its operation is essentially the same as that of a thermal power plant, except that instead of burning fossil fuels in boilers, uranium-235 is used as an energy source, although it is not burned, but rather undergoes a physical process called**nuclear fission**, which occurs in the so-called **nuclear reactor,**where enough heat is obtained to obtain the water vapor that will move the power plant's turbines.



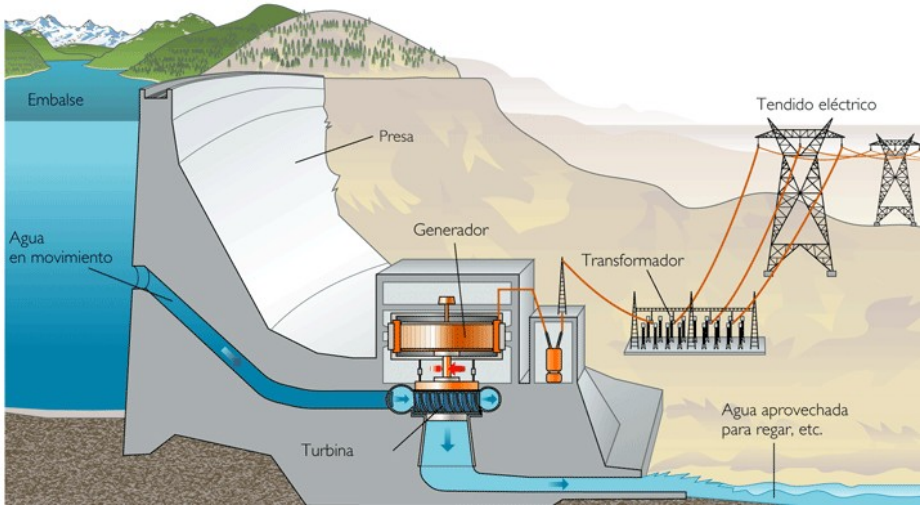
Nuclear fission, which takes place in a nuclear reactor, basically consists of splitting the nuclei of uranium atoms with neutrons. When a nucleus splits, it releases a huge amount of energy in the form of heat.



*If we bombard uranium atom nuclei with neutrons, some of them split, giving rise to smaller atoms. This process, which releases a large amount of energy, is called**NUCLEAR FISSION**and* it happens in the**NUCLEAR REACTOR**. *It is the foundation of nuclear power plants.*

HYDROELECTRIC POWER PLANT

In Spain there is a numberimportant of central hydroelectric that produce around 15% of the country's energy, although in rainy years this percentage can be much higher. In the Canary Islands, hydroelectric energy production is only 0.2% because it does not have large waterfalls.

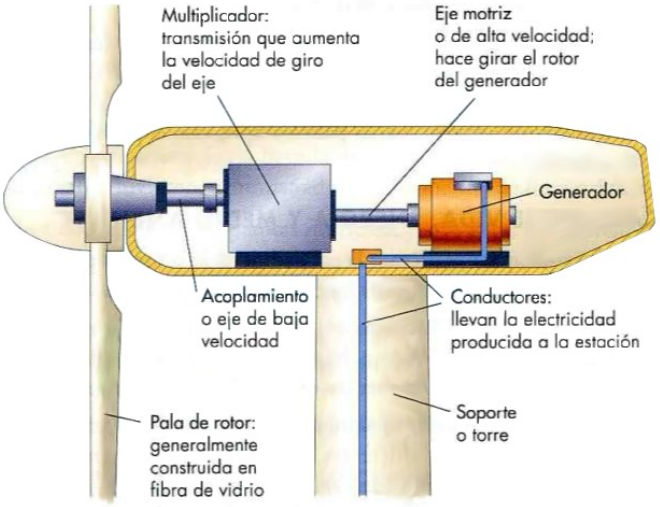


Its operation is based on accumulating water from the course of a river with dams and reservoirs. This water is at a certain height and the potential energy it stores is used. The water is allowed to fall and is conducted to the turbines of the power plant which, when turning, make the alternators turn.

WIND ENERGY

In Spain, nearly 20% of the energy produced is wind power. It is also produced in the Canary Islands, although its production percentage is ridiculous (barely a**4.4%**), despite having very favorable winds (the trade winds).

The machine that produces energy is called **wind turbine**, which you have surely seen. Its operation is simple. The wind makes the blades of the wind turbine move at a low speed. This circular movement is transmitted, thanks to a gearbox **multiplier**, to a shaft that rotates at a much higher speed and which in turn is connected to the alternator or generator.



PHOTOVOLTAIC SOLAR POWER PLANTS

In the Canary Islands, only 3% of the energy produced is solar photovoltaic, despite being the region of Spain with the most hours of sunshine.

Photovoltaic solar power plants perform a**direct conversion**from solar energy into electrical energy.

There are materials that have the property of generating electric current when light falls on them. These materials are used to build**photovoltaic cells**. A**solar panel**It is made up of several of these photovoltaic cells. The electric current generated by the photovoltaic panels can be consumed at the time or stored in a battery system. This way, the electric energy can be used outside of daylight hours.

ENVIRONMENTAL IMPACT OF POWER PLANTS

The construction and operation of a power station necessarily entails an ecological change in the area due to both the construction of the plant (buildings, communications, etc.) and the waste generated by its activity. This means that all power stations have an environmental impact, regardless of whether the energy they use is clean (does not produce pollution) or not.

For this reason, when building any power plant, an environmental impact assessment must always be carried out together with an assessment of the economic and social repercussions on the area in which it is located.

The following table shows a study of the main characteristics of the environmental impact of each type of power plant, as well as its risks and disadvantages and the advantages that, despite everything, its construction entails:

Type of central	Environmental impact	Risks and drawbacks	Advantages
Thermal	− Large buildings and roads must be built. - They contaminate the atmosphere because emit gases from combustion (CO_2, mostly). - They pollute and They heat sea and river water, used as a coolant. − They contribute to increase the effect greenhouse causing the planet's climate change.	- They cause diseases respiratory tract due to combustion gases. - They have a high noise level. − Uses non-renewable energy sources.	− These power plants They have great power and high performance.
Hydroelectric AC	− Large buildings and roads must be built. - Water reservoirs must be built river. - They seriously alter the location area due to water diversion and flooding of lands. − In times of drought, the ecological flow is sometimes not respected.	- There is a risk of the dam breaking and overflowing (there have been cases). − The construction of the dam and reservoir may cause the disappearance of native fauna and flora. − Sometimes they cause the eviction of populations whole. - In times of drought, yield is low.	− These power plants They have great power and high performance. − Does not emit polluting waste. - The water of the reservoir is used for irrigation and catering. − The energy source is renewable

Nuclear	− Large buildings and roads must be built. - The water is contaminated by radiation. − The waste is not recyclable and is highly contaminants.	- There is a danger of nuclear catastrophe (there have been cases). − It has high construction costs and large construction measures are required. security. - They generate waste radioactive waste that requires specific treatment and location (nuclear cemeteries) − There are risks of contracting radiation-related diseases. − It uses non-renewable resources.	− These power plants They have great power and high performance, even better than thermal power plants. − They do not emit greenhouse gases.
Wind	− Wind turbines They have visual and sound impact. − The set of wind turbines occupies large surfaces for your location. - There is a risk for birds.	- Wind is a discontinuous source of energy and random (it's not always windy) − Lower returns than previous ones. − There is a risk of accident in case of strong winds. − Wind turbines switch off if winds are too low or too high.	- The wind turbines no emit waste and That's why not pollute. - They reduce the dependence on other types of energy contaminants. - There is the possibility of self-consumption. - It is free and renewable source of energy.
Solar photovoltaic	− The installation occupies large areas to make it profitable. − The facilities have visual impact.	− The sun is a discontinuous source of energy and random (it's not always sunny) − Photovoltaic panels have low yields compared to solar panels. traditional power plants. − High costs.	− The facilities Photovoltaic are not pollutants already that do not emit waste - They reduce the dependence on other types of energy contaminants. - There is the possibility of self-consumption. - The source of energy is free and renewable.

REVIEW ACTIVITIES 1

1. Define energy.
2. Describe the types of energy you know.
3. (*)What types of energies are manifested or stored in the following objects or phenomena?:

   a) Moving train
   b) Lightning
   c) Thunder
   d) Chocolate bar
   e) Flying bird
   f) Electric current
   g) Lightning
   h) Water in a dam
   i) Water running in a river
   j) Boiling water
   k) Wood
   l) Nucleus of an atom
   m) Coal
   n) Wind
   o) Sun

4. What does the "*Principle of Conservation of Energy*"?

5. (*)Explain the energy transformation that occurs in the following examples:

   a) We light a barbecue
   b) We start the car
   c) We use a solar calculator
   d) Electric stove
   e) Light bulb
   f) Gas stove
   g) Speaker
   h) Battery
   i) Solar panel for heating water.
   j) Microphone.
   k) Electric motor.
   l) Fireworks
   m) Coal in a boiler.

6. Explain the difference between "***Energy Resource***" and "***Energy source***". Give two examples that illustrate this clearly.

7. Say whether it is true or false; if it is false, rewrite the sentence so that it is correct.
   a) In general, there are two types of energy sources: materials (such as fuels) and water.

   b) Gas is considered a source of energy.
   c) The sun is a renewable, non-conventional and non-polluting source of energy.
   d) Gasoline is considered a renewable and polluting source of energy.
   e) All energy sources pollute to a greater or lesser extent.
   f) Explain why electrical energy is the most widely used energy today.

8.**(*)**Think and complete the following table:

Initial energy	Final Energy	Machine
Luminous	Thermal	
Chemistry	Mechanics	
Electric	Thermal	
Electric	Mechanics	

9. Define the following words:
   a) Power plant
   b) Alternator
   c) Turbine

10. Using a turbine and an alternator we can produce electrical energy, how? Explain it in your own words, adding a drawing if necessary.

11. What are fossil fuels?

12. How can we produce electricity by burning fossil fuels? Explain it in your own words, indicating each step. What are these types of power plants called?

13.**(*)**Classify the following energy sources according to whether they are renewable or non-renewable:

   a) Solar

   b) Geothermal

   c) Nuclear.

   d) Hydraulics.

   e) Fossil fuels.

   f) Biomass

   g) Wind energy.

14. What is the purpose of cooling towers in thermal power plants?

15. What is the machine that transforms mechanical energy into electrical energy in a thermal power plant?

16. What is the environmental impact of the thermal power plant?

REVIEW ACTIVITIES 2

1. Indicate which of these statements is true and which is false. Explain each answer:

   a) Energy is not created.
   b) A hydroelectric power plant is a type of thermal power plant.
   c) Energy is expressed in a unique way.
   d) Energy sources, according to their use in industrialized countries, are classified as renewable and non-renewable.
   e) Electrical energy is a type of renewable energy.
   f) Nuclear energy is a type of conventional energy.

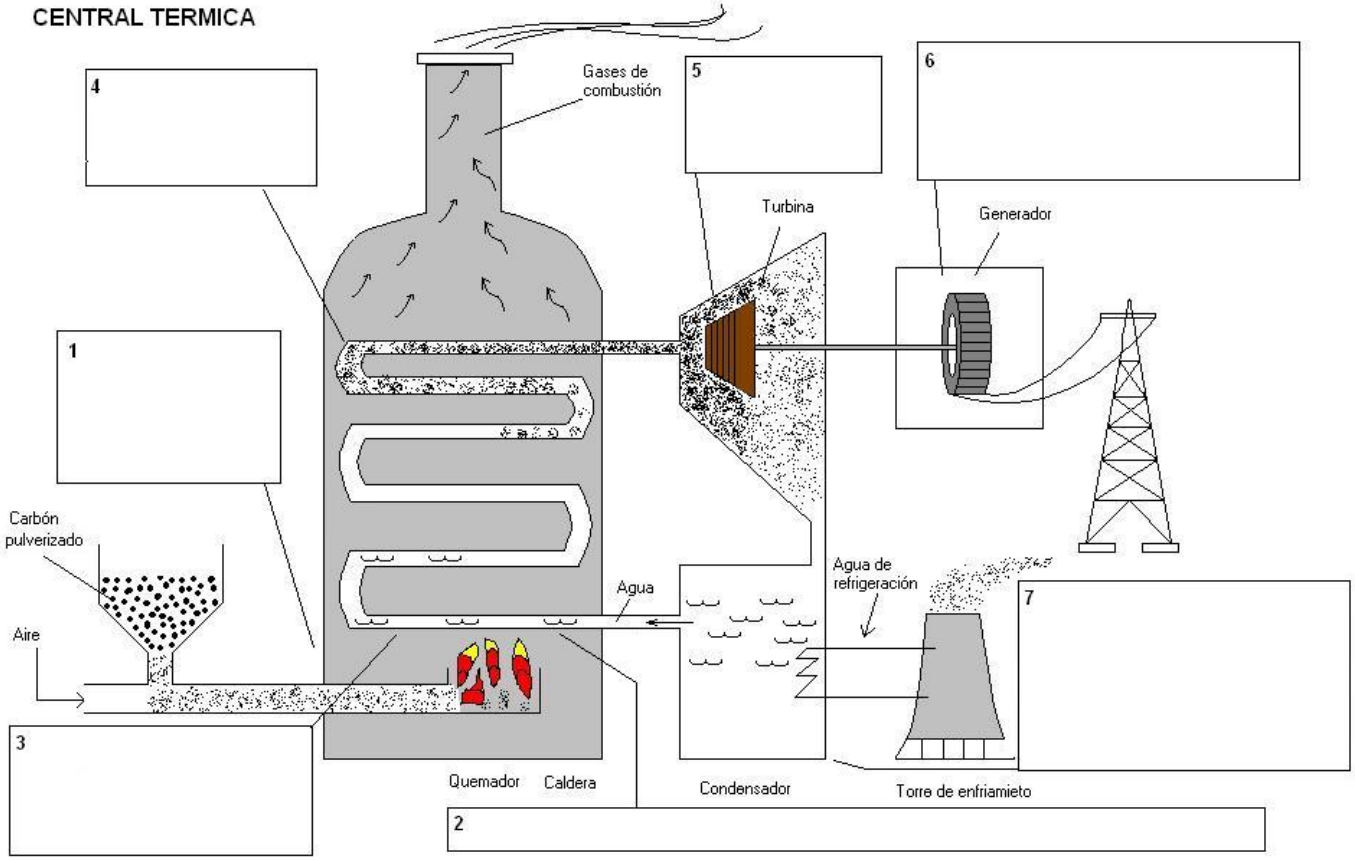
2. State two advantages and two disadvantages of nuclear energy. Explain your answers.

3. How can you save energy at home? And at your school?

4. Why is there a shortage of resources? What do you think are the characteristics that an ideal energy source should have?

5. List five technological mechanisms or systems from different fields that do not require electricity to operate. Time how long it took you to think of them and write them down. Repeat the test with five other mechanisms that do require electricity. What conclusion do you reach?

6.**(*)**Complete this diagram of a thermal power plant by briefly explaining the process by which electricity is produced.



REVIEW ACTIVITIES 3

1. (*) Complete the following table:

		Energy source	Pollutant or clean	Renewable or non-renewable
Power stations thermal	Of combustion			
	Central nuclear			
	Central solar thermal			
	Central geothermal			
Hydroelectric power station				
Photovoltaic solar power plant				
Wind power plant				

2. Explain why we have the turbine-alternator assembly in all power plants. What is it used for? How does it work?

3. State the environmental impact of the following power plants; add as a conclusion whether they are clean or polluting:
   a) nuclear b) hydroelectric c) wind power

4. (*) Explain what is the *greenhouse effect*. What are its consequences? What can we do to remedy it? Find information in books, encyclopedias and/or on the Internet.

ELECTRICITY AND ELECTRONICS

INTRODUCTION

As you will remember from previous courses, electricity is essential in our society, to the point that, if we lack it, we have a pretty bad time: we have no light, we cannot watch television or turn on the computer, if we have a ceramic hob we will not be able to cook, if our water heater is electric we will not have hot water, etc.

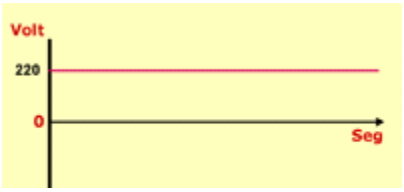
That is why it is so important to understand how this type of energy is produced and how to use it properly, trying to reduce its consumption so that our electricity bill is not high in cost, as well as to take care of the environment.

REVIEW OF WHAT WAS STUDYED IN PREVIOUS COURSES

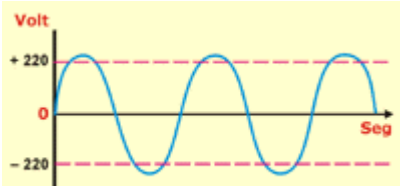
1. THE ELECTRIC CURRENT.

Electric current: is the movement of charges(usually electrons)**inside a driver**.

There are two types of electric current depending on how the electrons behave inside the conductor:



1 –**DC:**It is the one whose electrons always go in the same direction inside the conductor. And, in addition, its value is constant over time. Direct current generators have polarity (there are two poles of different signs). This is the same as batteries, car batteries, etc.

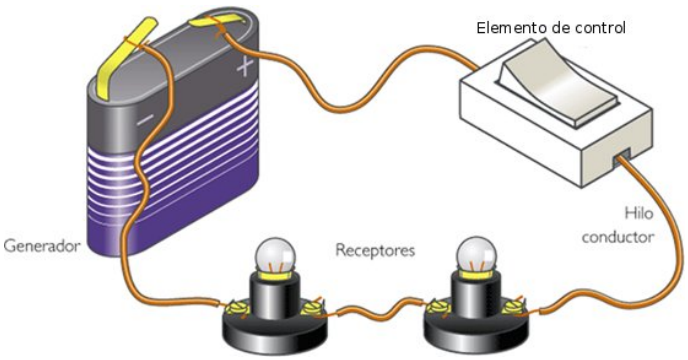


2 –**AC:**In this type of current, the electrons go back and forth inside the conductor, that is, they no longer follow a single direction. In addition, their value is no longer constant over time and changes from one instant to the next. Current generators do not have polarity. It is the current that reaches us at home from the electric company and is produced by large machines called alternators. But
It is also the current that the dynamos on our bicycles give us to turn on the lights.

2. ELECTRICAL CIRCUIT.

A**electrical circuit**it's aclosed route whose purpose is to carry energy from elements that produce it to other elements that consume it.

An electrical circuit consists of five types of fundamental elements.Without the first three types of elements no circuit can function and must always contain them. . The other two types of elements help us a lot in the control and safety of each circuit.



1 –**Generating elements:**They are the elements that provide energy to the circuit. Examples include batteries, alternators, dynamos, etc.

You must remember : The positive pole of a battery or any electronic element is called **anode** and the negative pole of the battery is called**cathode** .

2 –**Receiving elements:**These are elements that consume the energy provided by the generating elements. Examples include light bulbs, motors in household appliances, etc.

3 - Conductive elements: They are the elements responsible for carrying energy from the elements that generate it to the elements that consume it. They are usually cables. In some cases, such as flashlights, they can be small metal plates.

4 –**Maneuvering and control elements:**These are the elements that are responsible for allowing or not allowing the passage of current through the circuit. For example, switches, commutators, push buttons such as those on the doorbell, etc.

5 –**Protective elements**: They are responsible for protecting the circuit from overloads, that is, preventing more energy from passing through it at a given time than the consuming elements are capable of supporting. For example, fuses, differential switches in home installations (that is, that element that prevents us from getting current when we touch a plug with wet hands because it trips the circuit breaker. This is what used to be the fuses in old houses), etc.

NOTE: A circuit can work**only with the first three elements mentioned**, but if there is no control element to turn off the light bulb, the battery will quickly run out. That is why it is necessary to install a control element such as a switch. Protective elements are not usually used in simple circuits but in complex ones, such as those in homes or cars.

3. SYMBOLS.

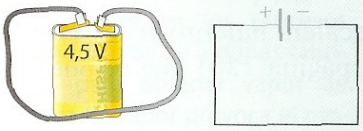
When designing circuits, elements are not used in their original form, as that would be quite complicated. Therefore, as you may remember, each element is assigned a symbol, which is the one that will later be used in circuit designs and which you must learn. Don't forget that each symbol of an element must have at least two pieces of wire, one where the current enters and another where it exits after passing through it. The following table shows the most common symbols:

Elemento	Símbolo	Función
Pila o batería		Genera corriente
Bombilla		Produce luz
Motor		Genera movimiento
Resistencia		Genera calor
Interruptor		Permite o impide el paso de la corriente
Conmutador		Alterna la corriente entre dos circuitos
Pulsador		Permite o impide el paso de la corriente durante cierto tiempo
Fusible		Protege el circuito
Empalme		Conecta dos partes del circuito
Timbre		Produce sonido

El *cortocircuito*

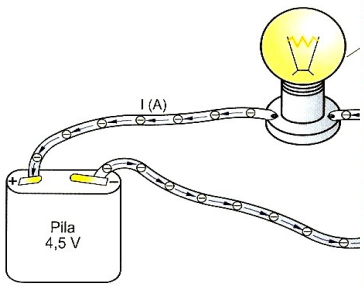
¿Qué pasaría si conectásemos directamente el cable de un polo a otro de la pila?

La corriente eléctrica pasaría sin obstáculos de un polo a otro, agotando la pila con mucha rapidez; esto es lo que llamamos un **cortocircuito.**



La pila de la ilustración sufriría un cortocircuito, y su energía se gastaría. Si el cortocircuito ocurriera en la red de nuestra vivienda, los elementos de protección saltarían inmediatamente, interrumpiendo el suministro; si no existieran estos elementos, el resultado sería la destrucción de la instalación y un incendio.

For example, here you have a real circuit with its light bulb and its battery and next to it is its schematic form, which is much simpler.

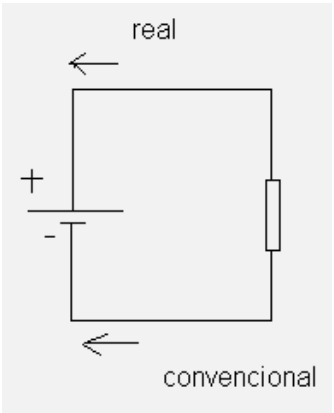


Interruptor. Tiene dos posiciones: una permite el paso de la corriente, y la otra, no.

Conmutador. Consta de dos salidas, esto es, se comunica con dos circuitos distintos, y hace que la corriente vaya hacia uno u otro, dependiendo de su posición.

Pulsador. Es como un interruptor, pero tiene una posición fija que se altera cuando pulsamos y a la que vuelve cuando dejamos de hacerlo.

4. DIRECTION OF THE CURRENT.

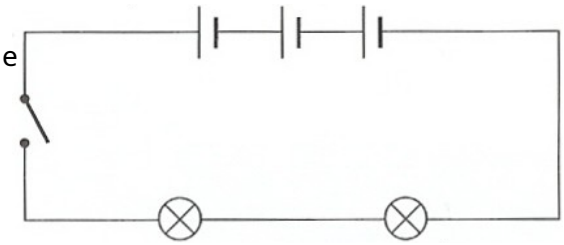


When atoms began to be studied, it was believed that the charges that moved were positive, but as studies progressed, it was discovered that the charges that really**They were moving*negative***. For this reason, for a long time the direction of the current coming out of the positive pole of the batteries has been drawn: this is what is called**conventional sense**of the current, because it is the one accepted by everyone and the one that appears in the books. But we must not forget that the**real sense**of the current is the one that comes out of the negative pole of the battery. This is not of great importance in electricity where polarity does not matter, but with electronic elements it is essential to take it into account because if we put them in the wrong way we break them.

5. TYPES OF CIRCUITS.

There are three types of electrical circuits: series, parallel and mixed circuits.

A simple way to explain the different types of circuits is to take into account that every element has current entering one end, traveling through it and exiting at the other end.

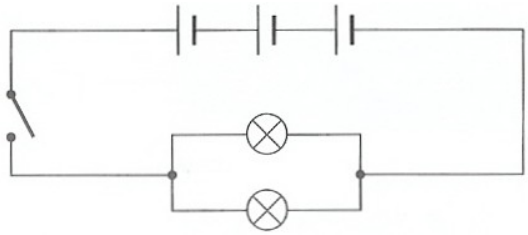


Series circuits: These are those in which the current output of one element is linked to the input of the next. This means two things:

1 – The current must completely pass through an element before it can enter and travel to the next.

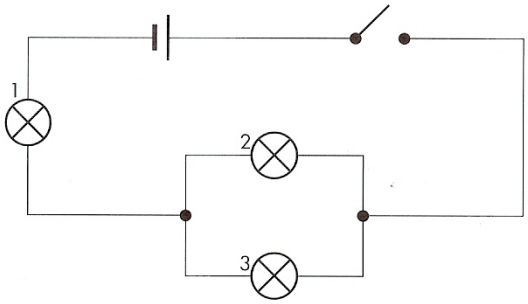
2 – It also assumes that there is only one path (branch) for the current, which in turn assumes that only There is a current intensity in the entire series circuit (or branch) and it is the same for all elements.

Parallel circuit: These are those in which all the current inputs of the elements are joined at a single common point; and all the outputs are joined at another common point. This means two things:



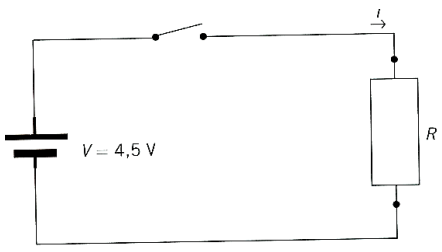
1 – The electric current now passes through all the elements in parallel at the same time because it enters through the common entry point and exits through the common exit point.

2 – This also assumes that there is a path (branch) for each element in parallel and not a single path as before. In this case, when several elements are found paths for the electrons to be distributed, not all branches will have the same current. But all the elements in parallel will have the same voltage since this magnitude is always measured between the current input and the output of each element, which is now common.



Mixed circuits: These are those that have elements or parts in series and in parallel at the same time.

6. OHM'S LAW AND THE MAGNITUDES THAT APPEAR IN IT.



Ohm's law: This law tells us that the energy supplied by the generating elements (batteries, alternators, etc.) is equal to the product of the intensity of the current circulating in the circuit (the electrons that move at a given moment) by the resistance offered by the consuming elements to the passage of said current (light bulbs, motors, etc.). This law is expressed mathematically in the following way:

$$V = I \cdot R$$

From this definition we deduce that all elements always offer a certain resistance to the passage of electrons through them and that is why, in circuits, we replace light bulbs with the value of the resistance they offer.

In the definition three magnitudes have appeared which are**electrical tension** (which is the force or energy provided by the generators),**current intensity** (the electrons that are passing at each instant) and**the resistance** offered by consumer elements.

Let's define these magnitudes and indicate the units of the**International System**(YES) in which they are measured:

Remember that magnitudes are the length whose unit is the meter, time whose unit is the second, mass whose unit is Kg, etc.

Voltage or electrical tension

You will also hear him call**strain**either**potential difference**((ddp). This is the energy provided by the generating elements, by making the electrons move within the conductor. If this energy did not exist, the lights could not be turned on or the appliances could not work.

In batteries, the energy supplied is always a constant value until the battery is depleted. There are rechargeable batteries, such as those in mobile phones.

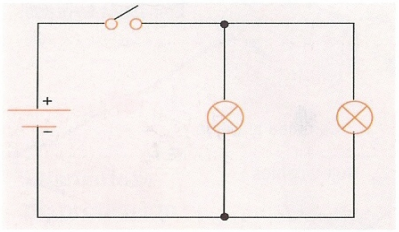
Voltage is symbolized by a "**V**" capital V, as you see in the Ohm's law formula.

In the International System its unit of measurement is**the volt** which is also symbolized by a capital "v",**V**.

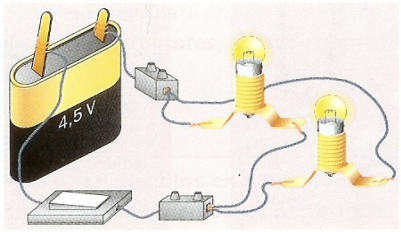
That's why, when you look at batteries you will see that some say 1.5 V, 3 V, 4.5 V, etc. And you will also hear that in homes the voltage is 220 V.

Current intensity or simply**intensity** .

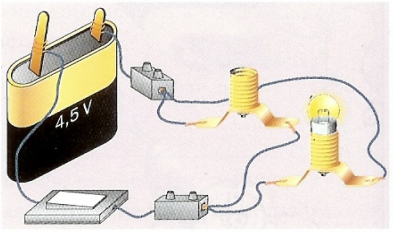
Bombillas en paralelo



Los polos de la pila están en contacto con los de cada una de las bombillas.



Cada bombilla está a la tensión de la pila. Si las bombillas son iguales, todas lucen por igual.



Cuando una bombilla se quita o se funde, las demás siguen luciendo.

This magnitude accounts for the number or quantity of electrons circulating at any given time in each branch of the circuit. If there is only one path or branch, the intensity will be the same everywhere. But if there is more than one branch, the electrons, like water, will be distributed across those branches.

Water is not distributed equally when it finds several paths to flow through, and more water will go through the wider ones than through the narrower ones. The same will happen with electrons, more will go through the branches that offer less resistance than through those that offer more resistance. This will depend on the elements that we place in each branch.

The current intensity is symbolized with a capital "i"**Yo**,and in the International System it is measured in**amps** whose symbol is a capital "a"**TO**. Remember that the ampere is a very large unit and that it is common to work with submultiples of it such as the**mA**(milliampere). One ampere is equal to 1000 milliamps.

Electrical resistance

It is the opposition that electrical elements offer to letting electrons (current) pass through them.

Electronic resistance

Resistance is symbolized by a*r*capital**R**, and in the International System it is measured in**ohms** , in honor of the discoverer of Ohm's law. Its symbol is the Greek letter omega,**-**.

There are some elements that are put in the circuits to make less electrons circulate through a delicate element, which if, for example, it received many it would break, and that is called**resistances,** and that you have seen among the elements and their symbols in the table that we already studied.

7. PLACEMENT OF MEASUREMENT ELEMENTS TO MEASURE ELECTRICAL MAGNITUDES.

Let's see how to place it**ammeter**(device for measuring current intensity), the **voltmeter**(device for measuring voltage (ol voltage) and**ohmmeter**(device for measuring resistance).

As you see in the examples, theammeter is always placed in series with the elements to measure their current intensity.

The voltmeter is always placed in parallel with the element whose voltage we are going to measure. In the case of the ammeter and the voltmeter, the current must be circulating through the circuit when the measurement is made or it will give us zero.

Heohmmeter is always placed in parallel with the element whose resistance we are going to measure, but to use this device there cannot be current flowing through the element. That is why it is usually removed from the circuit to measure its resistance or the current is disconnected to make the measurement, if we do not want to remove it from the circuit already built.

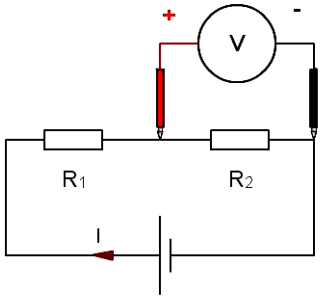
8. ENVIRONMENTAL IMPACT OF ELECTRICITY AND WAYS TO SAVE THIS TYPE OF ENERGY.

Electricity has revolutionized the use of machinery, various elements, household appliances, tools, etc., which has greatly facilitated tasks both at home and at work. Devices such as telephones, mobile phones, computers, etc. have been created, which would not have been possible without electricity.

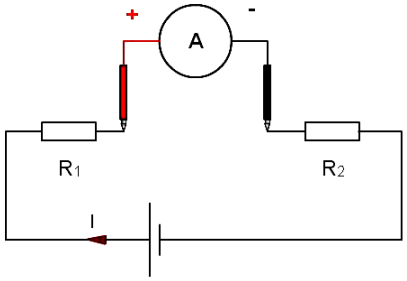
Electricity itself is not polluting and if used in accordance with the safety regulations for each electrical appliance, it should not cause us any harm. However, many of the ways of producing this energy are highly polluting, such as thermal power stations (which we use in the Canary Islands) that usually run on fossil fuels (oil, natural gas and coal), with urban solid waste (garbage) or biomass (pruning and harvesting residues) that emit large quantities of gases into the atmosphere, contributing to the greenhouse effect and climate change. Nuclear power stations are also used, the waste of which is even more dangerous and polluting.

Despite all this, our demand for electricity is increasing and if we want to preserve the environment, as we cannot abandon this type of polluting power plants, we must follow some electricity saving guidelines that allow us to consume less:

1. Replace incandescent light bulbs with energy-saving or fluorescent lamps.
2. Turn off lights and electrical appliances that are not in use.
3. Use the washing machine and dishwasher full.
4. Try to use the washing machine at the lowest temperature possible to save yourself the hassle of having to heat the water when using it.
5. Keep the refrigerator free of ice and frost if it is not "frost-free", and if possible, buy a refrigerator of this type since it does not form ice or frost.
6. When using a ceramic hob or electric oven, use the residual heat to finish cooking or heating the food, that is, turn off the hob or oven shortly before finishing cooking or heating the food because the remaining heat will finish cooking or heating it.
7. Do not open the electric oven unnecessarily to prevent heat from escaping.
8. Do not leave appliances on standby (with the light on), as this can consume up to 10% of total energy and can be considered a completely unnecessary expense.
9. Use more non-polluting renewable sources when producing electricity in power plants.



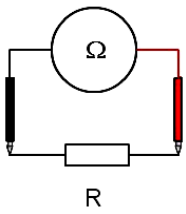
Placing the voltmeter



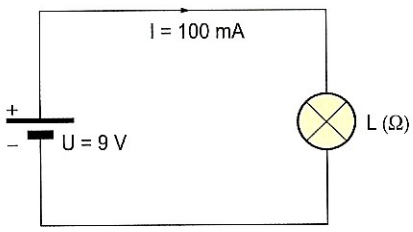
Placing the ammeter

10. APPLICATION OF OHM'S LAW TO DIFFERENT TYPES OF CIRCUITS.

In a simple circuit in which we only have a battery, a switch, cables and a power consuming element, we must Keep in mind that this element will always offer a certain resistance to the passage of current. For example, if we put in a light bulb it will offer less resistance than when we put in a motor, but in both cases there is resistance.



Placement of the ohmmeter



As you can see in these examples, in the first one we have a light bulb that has a certain resistance that we could calculate with Ohm's law since we know the intensity that circulates and the voltage of the battery. The second case is the same but instead of the light bulb we have placed a resistor that represents it, which is how we usually work in the problems.

Let's see an example: What intensity flows through a circuit if the battery has 4.5 V and the resistance is 100 Ω.

Equivalent resistance: When there is more than one consumer element in a circuit, whether in series, parallel or mixed, Ohm's law cannot be applied to the entire circuit without having previously found a way to reduce all the resistances to a single one that represents them all, since in Ohm's law we can only have a single resistance. This resistance that represents those we had initially is called**equivalent resistance**, because if we put it in the place of the others, both the voltage and the current intensity remain the same.

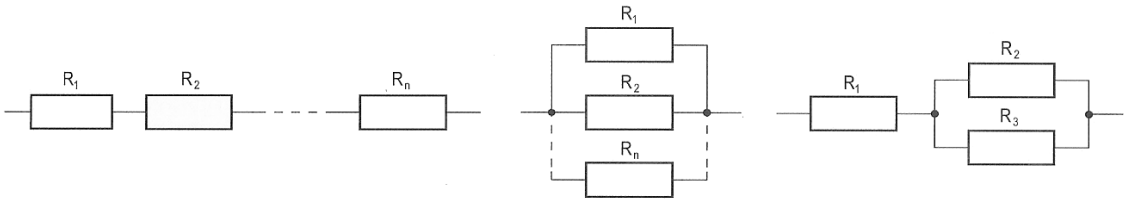
This equivalent resistance is calculated using a different formula, depending on how the elements are placed: in series, in parallel or in a mixed manner.

- *Equivalent series resistance:* It is calculated using the following formula: $R_{equivalent} = R_1 + R_2 + R_3$
- *Equivalent resistances in parallel:* It is calculated using the formula: $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
- *Mixed equivalent resistance:* the serial part is calculated with the formula

To calculate the equivalent resistance in series and the parallel part is calculated with the formula for equivalent resistance in parallel.

We always start by calculating the elements in parallel, so that we then have a new equivalent resistance of those in parallel, which will be in series with the resistors in series. In short...

Let's do some examples:



a) Serie. b) Paralelo. c) Mixto.

1. Calculate the equivalent resistance of two resistors in series of 10 Ω each.
2. Calculate the equivalent resistance of two parallel resistors of 10 Ω each.
3. Calculate the equivalent resistance for a circuit like c) if R_1= 10 Ω, R_2= 6 Ω and R_3= 6 Ω

11. USE OF OHM'S LAW TO CALCULATE THE MAGNITUDES OF EACH RESISTANCE THAT APPEARS IN THE CIRCUIT.

Series circuit: Remember that in series the current intensity is unique, so all the elements in series will have the same current, the one given by the battery. This means that, as the resistances are not equal, the voltages of each element cannot be either. But if there is one thing that is true, the voltage of each element in series, added to the others, can never exceed the one given by the battery.

Then the following expressions are fulfilled:

$$I_1 = I_2 = I_3 = \ldots = I$$
$$V = V_1 + V_2 + V_3 + \ldots$$

Parallel circuits: In parallel there is a branch for each element, which means that the current cannot be the same in all the resistors. But remember also that the voltage was measured between the current input of an element and its output. When in parallel all the elements have the same point to enter the current and it passes through all of them at the same time, then exiting through the common output point. This means that now what will be the same for all the elements in parallel will be the voltage.

Then the following expressions are fulfilled:

$$V_1 = V_2 = V_3 = \ldots = V$$
$$I = I_1 + I_2 + I_3 + \ldots$$

Mixed circuit: As with resistors, in a mixed circuit the above formulas are fulfilled in the series part for series circuits and the parallel formulas for the part of the parallel elements.

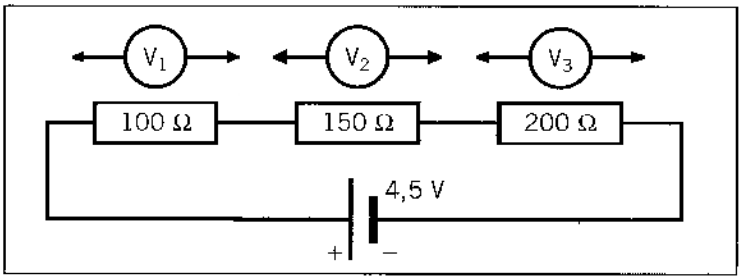
That is, Ohm's law applies to the entire circuit but it also applies individually to each consumer element in the circuit, that is, to each resistor. Let's study some examples:

1 – Series resolution :

Example

a) Find **current intensity** that generates the stack

Since the resistors are in series, the intensity of current that flows through each resistor is the intensity generated by the battery, which can be found from the equivalent resistance.



$$R_{equivalent} = R_1 + R_2 + R_3$$

$$R_{equivalent} = 100\text{-} + 150\text{-} + 200\text{-} = 450\text{-}$$

The current intensity generated by the battery is found with Ohm's law and is the same as circulates through each resistance

$$Yo_{Total} = \frac{V}{R_{equivalent}} = \frac{4.5\,V}{450\text{-}} = 0.01\,TO$$

b) Find the **voltage across each resistor (V_1,V_2,V_3).**

Knowing the current intensity, Ohm's law can be applied to find the voltage across each resistor.

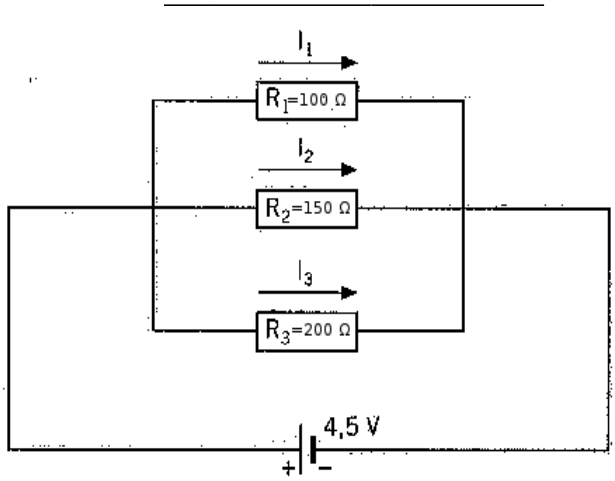
$V_1 = Yo_{Total} \cdot R_1$ $V_1 = 0.01 \cdot 100 = 1\,V$

$V_2 = Yo_{Total} \cdot R_2$ $V_2 = 0.01 \cdot 150 = 1.5\,V$

$V_3 = Yo_{Total} \cdot R_3$ $V_3 = 0.01 \cdot 200 = 2\,V$

It can be verified that the sum of the voltages of each resistor must be equal to the battery voltage.

$$V_1 + V_2 + V_3 = 1\,V + 1.5\,V + 2\,V = 4.5\,V$$



example

there **current intensity** that generates the stack,

are not in parallel, we must first find the resistance valent ($R_{equivalent}$) ...

$$\frac{1}{R_{equivalent}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \quad \frac{1}{} = \frac{1}{100} + \frac{1}{150} + \frac{1}{200} \quad \frac{6+4+3}{600} = \frac{13}{600}$$

We turn the result around $R_{equivalent} = \frac{600}{13} = 46{,}15\text{-}$

the intensity of the current (Yo_{Total}) that generates the stack is found with Ohm's law

$$Yo_{Total} = \frac{V}{R_{equivalent}} = \frac{4.5\,V}{46{,}15\text{-}} = 0.0975\,TO$$

b) Find the intensity of current that passes through each resistance (I_1, YO_2, YO_3)

The intensity of current that flows through each resistor is different, and is calculated by applying Ohm's law.

$$I_1 = \frac{V}{R_1} = \frac{4{,}5\ V}{100\ \Omega} = 0{,}045\ A$$

$$I_2 = \frac{V}{R_2} = \frac{4{,}5\ V}{150\ \Omega} = 0{,}03\ A$$

$$I_3 = \frac{V}{R_3} = \frac{4{,}5\ V}{200\ \Omega} = 0{,}0225\ A$$

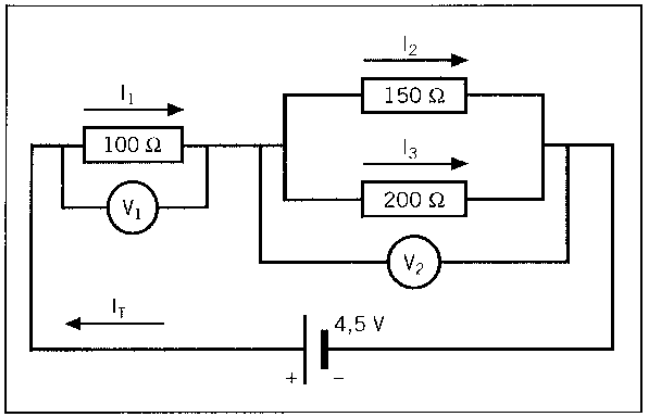
It can be verified that $I_1 + I_2 + I_3 = 0.045 + 0.03 + 0.0225 =$ 0.0975 A equals the intensity of the total current.

c) Find the voltage consumed by each resistor (V_1, V_2, V_3). When resistors are in parallel, the voltage between the ends of the resistors is the same for all of them and is equal to the battery voltage.

$$V_1 = V_2 = V_3 = V = 4.5\ V$$

3 – Resolution in the case of a mixed circuit:

Example



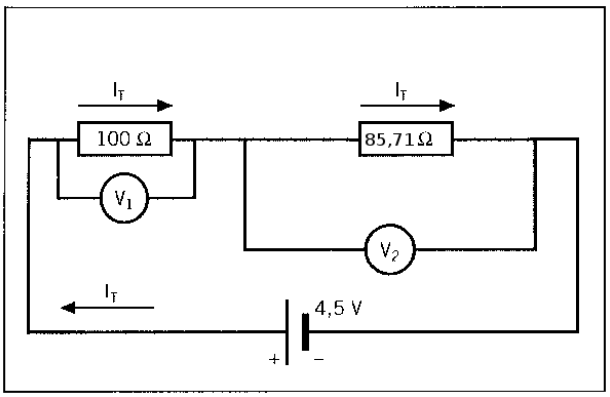
a) Find **the intensity of current generated by the battery (*Yo*Total)**

As in the previous cases, we must find the Equivalent Resistance ($R_{equivalent}$). To do this, we solve the two resistors that are in parallel

$$\frac{1}{R_{equivalent.parallel}} = \frac{1}{150} + \frac{1}{200} = \frac{4+3}{600} = \frac{7}{600}$$

We give it to you

return → $R_{equivalent.parallel} = \frac{600}{7} = 85.71-$



Simplified circuit

Now the above circuit can be replaced by a simpler one that combines the two resistors in parallel.

The total (and final) equivalent resistance can be found easily because in this circuit the resistors are in series and you just have to add the values.

$R_{equivalent.total} = R_1 + R_{equivalent.parallel}$

$R_{equivalent.total} = 100- + 85.71-$

$R_{equivalent.total} = 185.71-$

The intensity of current generated by the battery is found by Ohm's law, as always

$$Yo_{Total} = \frac{V}{R_{equivalent}} = \frac{4.5V}{185.71-} = 0.0242\,TO$$

b) Find the **voltage across each resistor (V_1, V_2, V_3)**

$V_1 = Yo_{Total} \cdot R_1 = 0.0242 \cdot 100 = 2.42\,TO$

$V_2 = V_3 = Yo_{Total} \cdot R_{equivalent.parallel} = 0.0242 \cdot 85.71 = 2.42\,TO = 2.07\,V$

In this case the 150 Ω and 200 Ω resistors have the same voltage (V_2=V_3), while the 100 Ω resistor has the voltage V_1To solve the problem, we look at the second simplified circuit.

c) Find the **intensity of current that flows through each resistance (I_1, YO_2, YO_3)**

The current passing through the first resistor is the same as that generated by the battery. ($I_1 = I_{total} = 0.0242$ A)

To find the other values of the current intensity, we resort to Ohm's law. Note that to apply Ohm's law, you must know that the second and third resistances support a voltage whose value is $V_2 = 2.07$ V

$$Yo_2 = \frac{V_2}{R_2} = \frac{2.07\,V}{150-} = 0.0138\,TO \qquad Yo_3 = \frac{V_2}{R_3} = \frac{2,07\,V}{200-} = 0.0103\,TO$$

12. POWER AND ENERGY. CALCULATION OF ENERGY CONSUMPTION AND ITS COST.

When we buy a household appliance or a simple light bulb, we always look at the power consumption. You will have seen 40 W, 50 W bulbs or low consumption ones that use less power, 7 W, 5 W, etc.

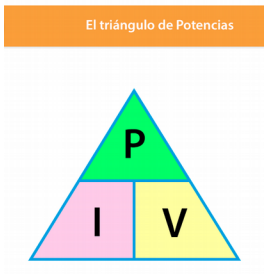
When we talked about saving energy, we saw a table that told us that the power consumption of an appliance depends on its class. Those that require the least power are those in class A, then those in class B, and so on.

We have to take all of this into account when saving, but not when calculating the power being used, the energy we consume and what the electric company charges us for said consumption.

Let's start with the power: **Power**

Every consumer element placed in a circuit has a power that we have already said appears among the characteristics of the consumer elements that we buy. Thus, a hair dryer can tell us 800 W, 1000 W or more, as can a vacuum cleaner, a computer, a television, etc.

The *electrical power* We will define it as the capacity that a consumer or receiver element has to transform energy in a given time, which will be the time that it is connected and working. If a light bulb is off, it is not consuming energy, but if we turn it on, it does. Its symbol is a capital "p": **P**.



In the international system power is measured in **watts** whose symbol is a capital "w": **W**.

The power consumed by an electrical device through which a current I circulates, and whose operating voltage is V, is given by the expression:

$$P = I \cdot V$$

$$I = \frac{P}{V} \qquad V = \frac{P}{I}$$

If we know the voltage of our houses which is 220V and the power of the like 40W or 60W light bulbs, or the 1000W hair dryer, or the 1000W or 1500W stove, etc.; we can know the intensity of the current that flows through said appliance:

We can also calculate the operating voltage of the device if we know the power and current intensity:

But we can also know the resistance that the device offers to the passage of current through it by using Ohm's law:

$$V = I \cdot R$$

Then making combinations we obtain:

$$P = I^2 \cdot R$$

Energy

We have seen that voltage is the energy provided by the generating elements to the electrons to keep them moving within the circuit and to create an electric current. As we have already said, this energy is consumed by the consumer or receiving elements.

The energy consumed by an electrical appliance during a**time**certain,**t**, through which a current I flows and whose operating voltage is V, responds to the expression:

$$E = P \cdot t$$

As you can see, energy is related to the power consumed by each appliance. If a 60 W bulb is working for one hour, it will consume less energy than if it is working for four hours.

In the international system, energy, as you may recall, is measured in Joules, which is a very small unit of measurement. But if you look at any electricity bill, you will see that we are not charged for energy in Joules but in**kilowatts**-**hour**That is, what the electric companies are interested in is the**kWh**that we consume in the hours during which we do so.

This means that when in a problem we get the**power**of a device or they give it to us in watts, we have to convert it to**kW**. And since we know that in the international system time is measured in seconds, we must always pass the**time to hours**.

When we have converted the power to kW and the time to hours, the**energy**will be measured in **kWh**, which is what we are charged on our electricity bills. They tell us the price of a kWh and tell us the amount of kWh we have consumed each month. This way we can calculate the cost of our electricity consumption.

Cost of energy consumed

As we have indicated in the previous section, the electric companies always indicate the price of a single kWh on the bill and offer us the reading for a specific day and a subsequent day. By subtracting these two readings we obtain the amount of kWh that we have consumed in that period. Then the cost**C**, the energy will be the product of the kWh consumed, that is, the energy consumed in that period**AND**, for the unit price**or**, of a single kWh:

$$C = E \cdot u$$

If we apply this expression to a normal day in our home, we can find out what the average price of our energy costs is. To do this, we have to take into account that the refrigerator will always be on, the hours of television or televisions on, the light bulbs, computer and any appliance that we normally use. This will make us realise how much we consume and how much we can save if we take care to turn off everything that is not in use.

13. ELECTRICAL RESISTANCE: COLOR CODE.

Electrical resistance.

We have already seen that any consumer element, and even generating elements, present a certain resistance to the passage of current. But it is not this resistance that interests us now but rather elements called**resistances**which are normally placed in circuits to protect other consumer elements.

These resistors can be of various types, as you will see in 4th ESO, and are used for various purposes, such as for example that they are open and close circuits depending on variations such as temperature (in a fire sensor), light, etc.

Nowadays, resistors are often used to limit the flow of current through the circuit branch and to protect electronic elements, of which there are many in our society, as you can see by simply looking around you: MP3, mobile phone, computer, multifunction device, washing machine programmer, dryer programmer, etc.

The resistors that are purchased on the market have specific values that we can calculate with the**color code**This means that there are no resistors on the market of any value that we need. Therefore, it is necessary to combine them in series, in parallel or in a mixed way, until obtaining the protection value that our electronic component or components need.

Color code

The color code allows easy identification of the theoretical value of a resistor. This code consists of**four stripes**: three of them, those that are closest to each other, provide the theoretical value of the resistance; while the fourth band, which appears somewhat further apart, provides us with the value of the**tolerance**, that is, the margin of error on the theoretical value indicated by the first three bands. This tolerance is a value that fluctuates around the theoretical value, and values lower or higher than those given by the initial colours can be measured with an ohmmeter. In other words, the real value of the resistance will fluctuate around the theoretical value depending on the tolerance interval presented by the resistance.

When we want to obtain the resistance value, we must place it horizontally with the tolerance band to the right. To obtain the theoretical resistance value, we begin to read the bands from left to right as follows:

1–**First strip**(1ºf): corresponds to the first digit, that is, to a number.

2–**Second strip**(2ºf): corresponds to the second digit, that is, a number.

3–**Third strip**(3ºf): is a multiplying factor and corresponds to the number of zeros that must be placed after the first two digits.

4 –**Fourth strip**(4ºf): is the tolerance.

Color	1.ª cifra	2.ª cifra	Factor multiplicador	Tolerancia
Negro	0	0	× 1	
Marrón	1	1	× 10	±1 %
Rojo	2	2	× 100	±2 %
Naranja	3	3	× 1.000	
Amarillo	4	4	× 10.000	
Verde	5	5	× 100.000	
Azul	6	6	× 1.000.000	
Violeta	7	7	× 10.000.000	
Gris	8	8	× 100.000.000	
Blanco	9	9		
Oro				±5 %
Plata				±10 %

Códigos de colores para identificar el valor en ohmios de una resistencia.

We can see the color code in the table above:

Although the table assigns tolerance values for brown and red, we are only going to work with color tolerances.**gold**and**silver**. And more specifically with the gold one. As you can see, the tolerance has a plus-minus sign and is a percentage.

To illustrate how to solve these calculations we are going to give a concrete example and we will do the steps one by one. But first we are going to see what the theoretical value is (V_T), the actual values (V_R) and tolerance (Tol).

From mathematics you will know what a range of numbers is that are represented by the lowest value of the range separated by a comma from the highest value, and both in parentheses: (a,b).

Well, tolerance will help us obtain this range of possible real values by calculating the percentage of the theoretical value given by the first three figures, then subtracting it to obtain the lowest value; and then adding it to obtain the highest value.

That is to say:

$$V_R = (V_T - Tol, V_T + Tol)$$

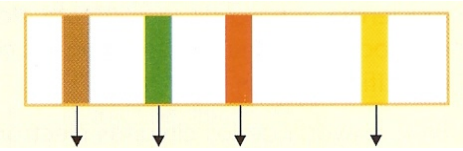
To understand this, let's assume that with the first three bands we have obtained a value of 3000 - and let's assume that the tolerance is ±10%. Since the tolerance is a percentage, remember that it is multiplied by the number that has the percentage and divided by one hundred. That is:

$$Tol = V_T \cdot 4^{o}f /100 = 3000 \cdot 10/100 = 300 -$$

Then the actual values will be:

$V_R = (V_T - Tol, V_T + Tol) = (3000 - 300, 3000 + 300) = (2700 -, 3300 -)$.

Example: Suppose we have a resistor whose colors are: brown, green, red and gold.



1st stripe 2nd stripe 3rd stripe 4th stripe (tolerance)

Steps to follow:

d) 1st stripe: brown = first figure = 1

e) 2nd stripe: green = second figure = 5

f) 3rd stripe: red = number of zeros = 00

g) $V_T = 1500-$

h) 4th band: ±5 = Tol = 1500 · 5/100 = 75-

i) $V_R = (V_T - Tol, V_T + Tol) = (1500 - 75, 1500 + 75) = (1425 -, 1575 -)$

j) $V_R$obtained with the ohmmeter: this is the value that we will read with the multimeter, a device that can act as a voltmeter, ammeter and ohmmeter, to facilitate the number of devices we work with.

According to the range of values we have obtained, when reading with the ohmmeter we can obtain values 1497 -, 1502 -, 1570 -, etc., because they are values that are within the range of possible real values. But if we read 1403 - or 1598 -, we will have made the calculations wrong because those values are not within the range and are not possible real values of the 1500 - resistance with a tolerance of ±5%.

Multimeter

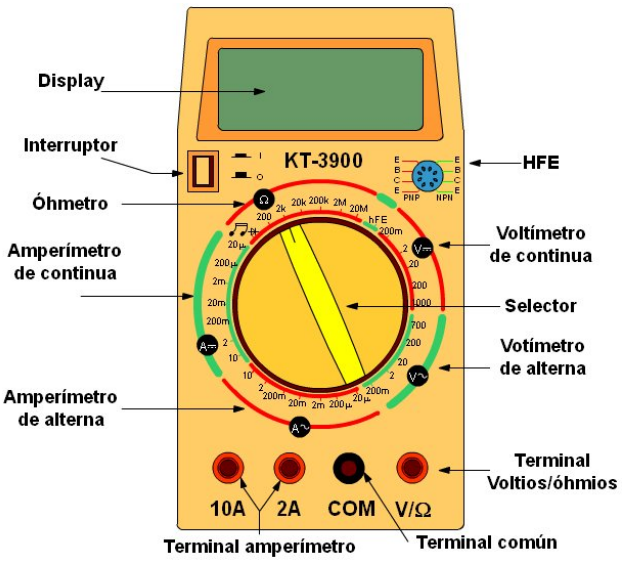
The multimeter or tester is a device that can act as**ammeter**,**voltmeter**or **ohmmeter**, among other measuring devices. Remember that when it acts as an ammeter it must be placed in series in the circuit and when it acts as a voltmeter, in parallel with the device whose voltage we want to measure (in these two cases the current must be circulating through the circuit). When it acts as an ohmmeter it is also placed in parallel but current cannot be circulating through it. That is why it is better to make the measurements with the resistance outside the circuit.

There are two types of multimeters, the**analogue**that give us the measurement by means of a needle, and the **digital**, which are the ones we are going to use to take measurements.

As a precaution to safeguard the multimeter, you should always start the measurement with a higher measurement than you think, in case you have made a mistake in your calculations. This way, you protect the device by not making it measure something very high, where it should be measuring something smaller.

Another thing to keep in mind is that sometimes you will get negative measurements. This is due to the polarity to which the tester is sensitive. To get the positive value, simply swap the pointers when measuring.

Analogue multimeter



Digital multimeter

Let's see what the multimeter that we usually use in the classroom-workshop is like and how it measures the three basic magnitudes. You will see that you can measure the current and voltage in**continue**, whose symbol you will see is**-**, and also ⎓ You will be able to measure these magnitudes in**alternates**whose symbol is **"~"**.

Digital multimeter

OFF: Position to turn off the multimeter.

1.**V/-**:Connection for measuring voltage and electrical resistance. Red cable.

2.**COM**: Common connection. The black wire is always connected

3.**mA**: Connection to measure the current intensity. Red cable. Supports a maximum of 200 mA = 0.2 TO.

4.**TO**: Connection for measuring current intensity. Red cable. Supports a maximum of 20 A.

Scale

Test transistors

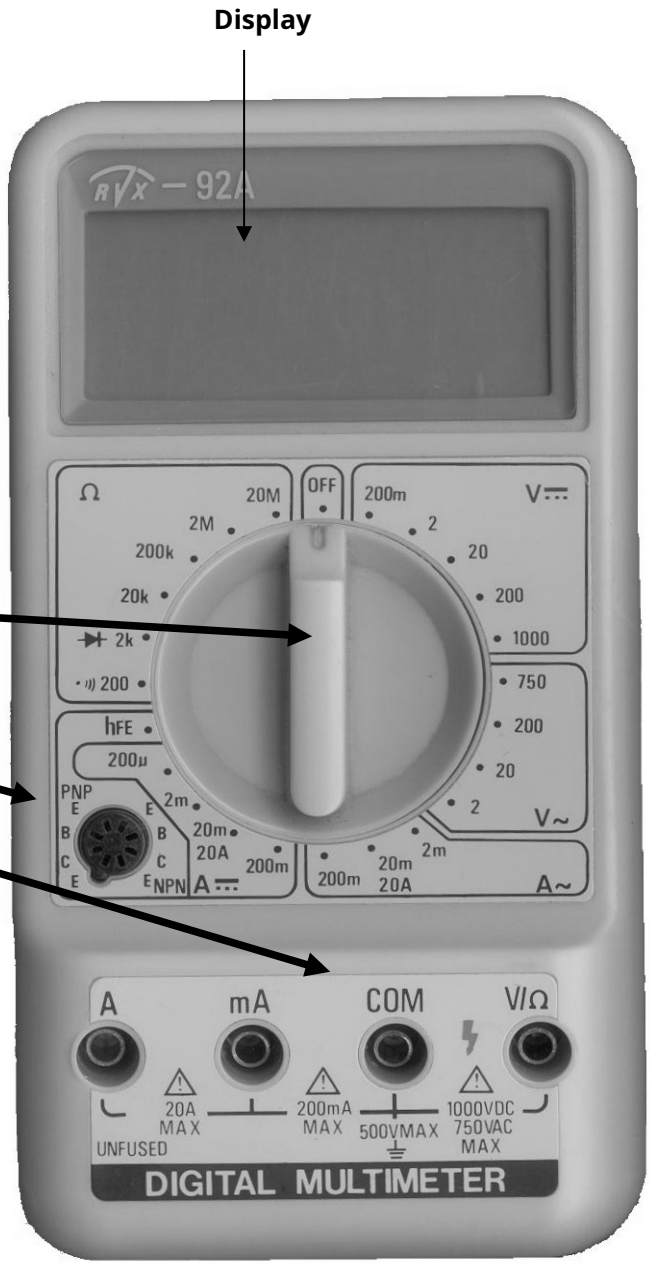
Connections

5. The cable red represents the pole positive .

6. The cable black It is the pole negative

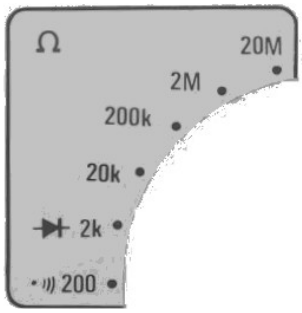
The maximum voltage that the multimeter supports if the current is direct is 1000 V.

The maximum voltage that the multimeter supports if the current is alternating is 750 V.



Scale of resistance

This scale measures electrical resistance in Ohms, from 200 - to 20 M- = 20000000 -



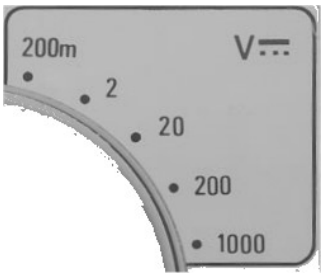
The cable connection is as follows:

a) Black wire: connection**COM**
b) Red cable: connection**V/-**

The '200' position has another function: if the two cables are placed at two different points and a high-pitched sound is heard, the multimeter indicates that there is hardly any electrical resistance between those two points, meaning that the electrical current could flow between those two points.

Direct current voltage scale

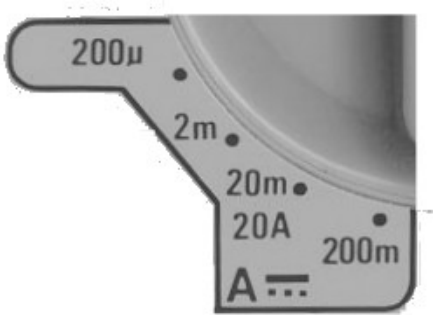
This scale measures the electric voltage if the current to be measured is continuous. The scale ranges from 200 mV = 0.2 V to 1000 V.



The cable connection is as follows:

a) Black wire: connection**COM**
b) Red cable: connection**V/-**

Direct current intensity scale



This scale measures the intensity of the electric current if it is continuous. The scale goes from 200 -A = 0.0002 A to 200 mA = 0.2 A.
The cable connection is as follows:

a) Black wire: connection**COM**
b) Red cable: connection**mA**

It is used to measure low current intensities, typical of the electronic field.

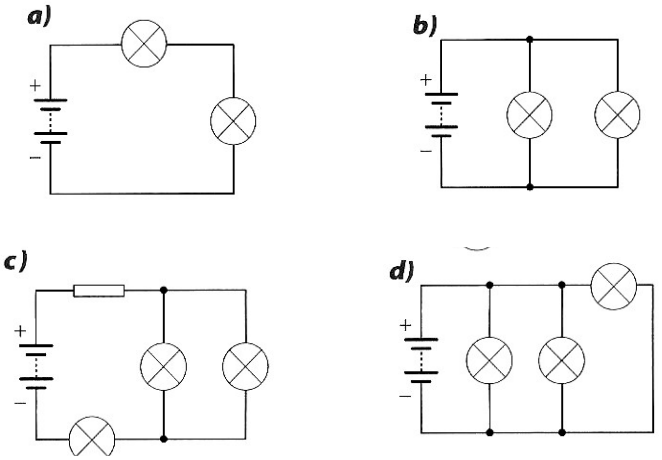
ACTIVITIES

1 –Define: electrical circuit and short circuit.

2 –a) What is the voltage of a battery? How is it measured?
b) What is current intensity? How is it measured?
c) What is the resistance of an electrical element? How is it measured?

3 –a) What are the basic elements that all circuits must have?
b) What happens if any of these elements are missing?
c) Name the five elements that it must have, and without which it could not function.

4 (*) –Indicate which elements of the following mixed s circuits:



5 –a) What does it mean when the elements of a circuit are connected in series? Define being connected in series.
b) What does it mean that the elements of a circuit are connected in parallel? Define being connected in parallel.
c) What does it mean that the elements of a circuit are connected in a mixed way? Define be connected in a mixed way.

6 –a) Define electric current and indicate how many types there are. b) Define the types of current that exist.

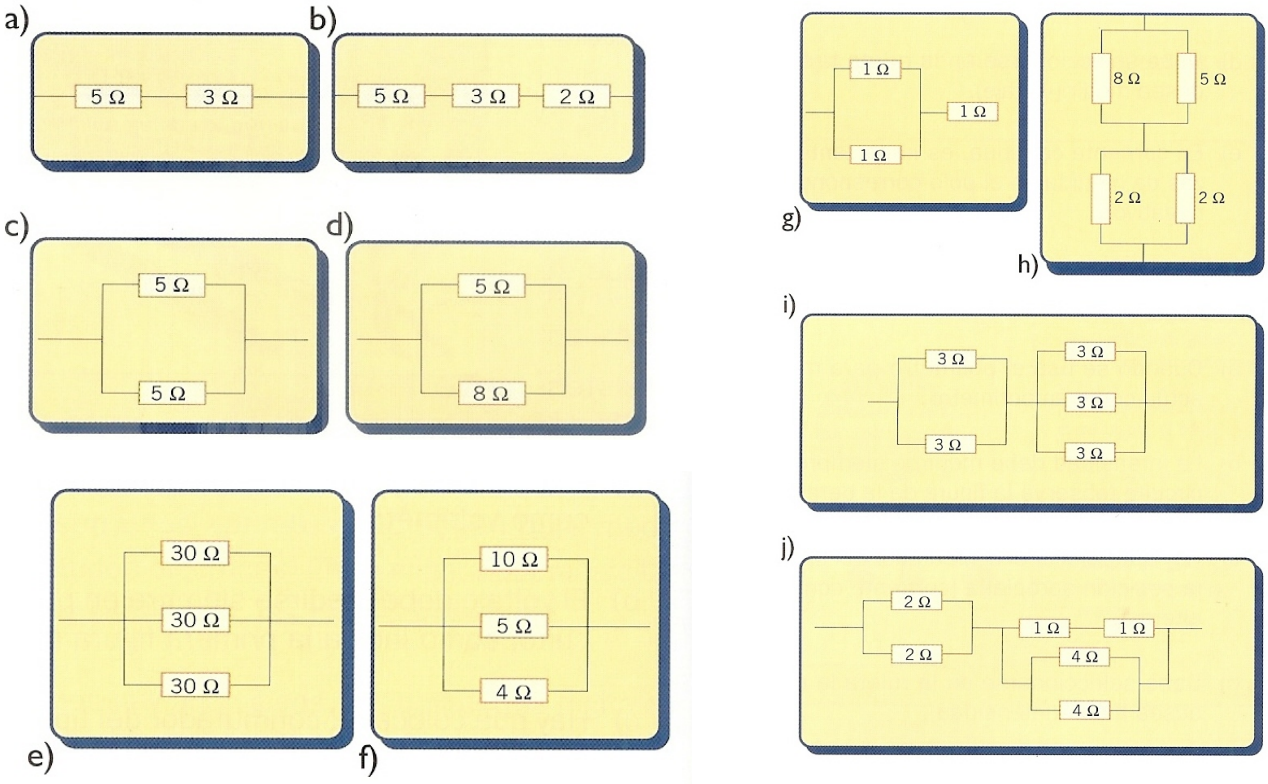
7 –Imagine that you have two light bulbs, one of which is burned out, and two batteries, one of which is dead. What would you do to find out which battery is dead and which light bulb is burned out?

8 –A 3 k- resistor is connected to a 4.5 V battery. What will be the current that runs through the circuit?

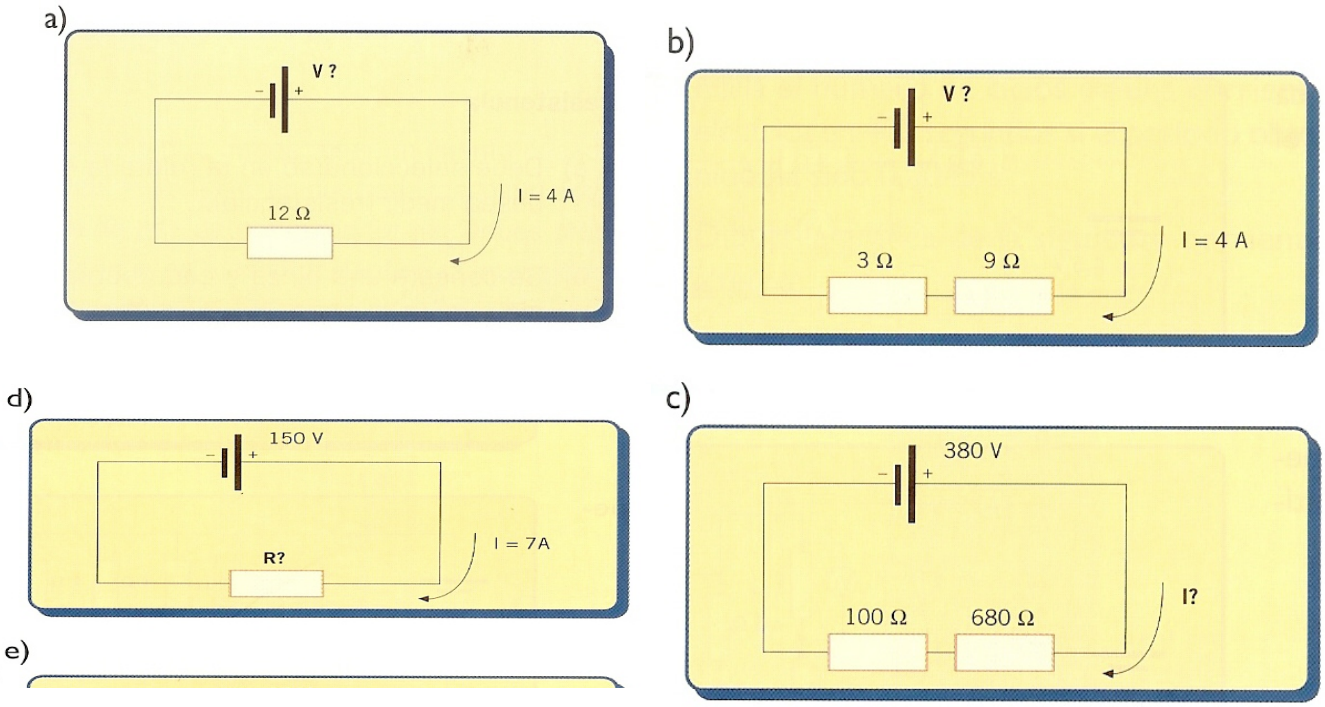
9 –We have a light bulb connected to a 6 V battery through which a current intensity of 0.35 A flows. What will be the resistance of the light bulb?

10 –Calculate the voltage value of a 100 Ω bulb through which 100 mA flows.

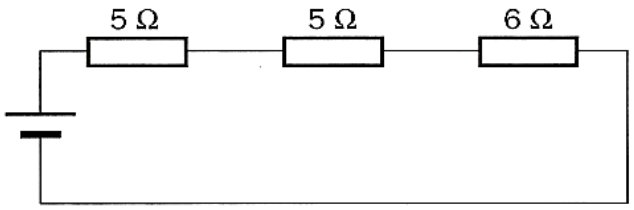
11 –Find the equivalent resistance in the following cases:



12 –Calculate the missing parameter in each of the following circuits:



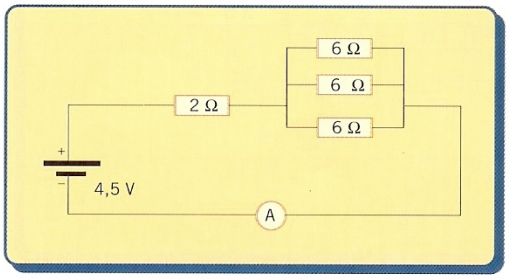
13 –Calculate:



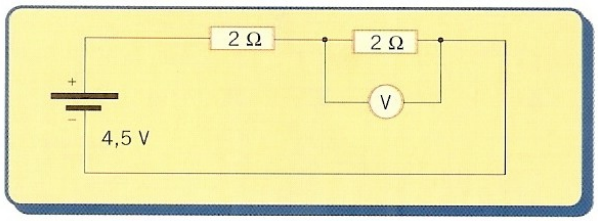
a) The voltage, if the intensity is 0.5 A

14 –Solve the following sections:

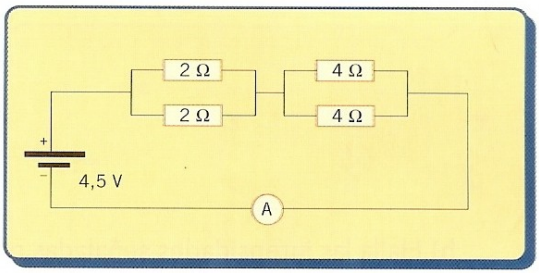
a) Halla la intensidad que marca el amperímetro.



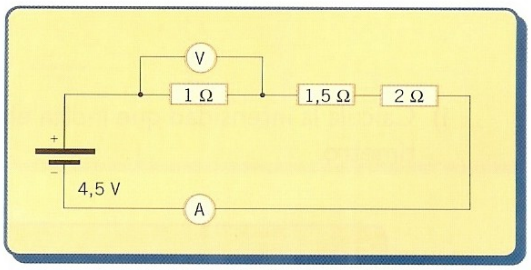
b) Calcula la diferencia de potencial que indica el voltímetro.



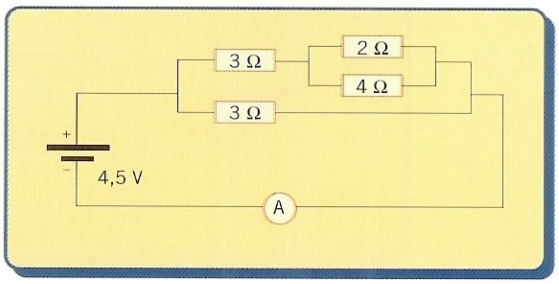
c) ¿Qué intensidad indica el amperímetro?



d) Averigua la intensidad que indica el amperímetro y la diferencia de potencial que marca el voltímetro.



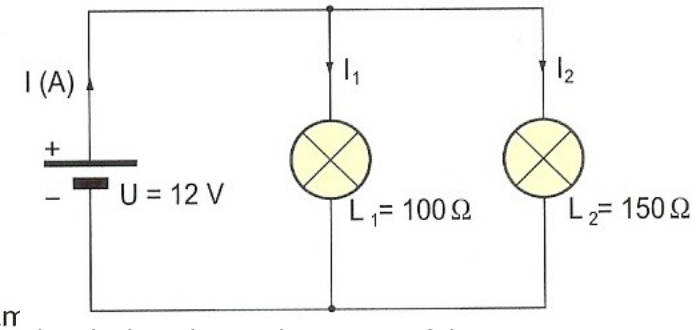
e) ¿Qué intensidad indica el amperímetro?



f) Calcula la diferencia de potencial que indica el voltímetro y la intensidad que muestra el amperímetro.

g) nperíme- los voltí-

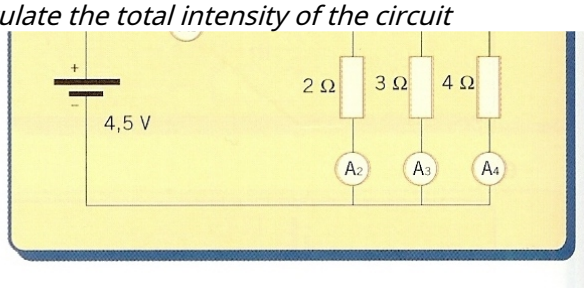
b) The total intensity of the circuit



c) Calculate the total intensity of the circuit.

h) Halla las intensidades señaladas por los am rímetros Al, A2, A3 y A4.

d) Calculate the total intensity of the circuit



15 –A light bulb consumes 0.3 A. What power does it consume if it is connected to a 220 V home?

16 –Calculate the power value of a 55 Ω, 220 V bulb.

17 –What intensity flows through a 60 W bulb connected to 220 V?

18 –a) Find the intensity that flows through a light bulb that is connected to a 220 V network, if its resistance is 150 Ω. b) What power does it consume? c) And what energy if it is connected for 75 min?

19 –Calculate the energy consumption of an electric water heater with a power of 350 W and operating for 45 min, if the price per kWh is €0.09.

20 –A 40 W bulb is switched on for 3.5 hours. What is the cost of energy consumption if the kWh costs €0.1?

21 – (*)If the price of kWh is €0.15, what is the individual and total cost of the following appliances that are connected in one day as follows:

Household appliance	Power in W	Power in kW	Time of use	Energy consumed	Individual cost
Washing machine	600W		1'5h		
Fridge	200W		24h		
Dryer	900W		2h		
Electric water heater	400W		2'5h		
Vitroceramic	1.600W		4h		
Iron	1.000W		2h		
Television	250W		6h		
Computer	150W		5h		
Electric oven	900W		1'5h		
Microwave	300W		2h		
Dishwasher	900W		2h		
Light bulbs	600W		8h		
	Total cost of energy consumed in one day				

22 – (*)Calculate the theoretical value and all possible actual values of the following resistors:

a) Green, blue, brown, gold.

b) Brown, grey, brown, gold.

c) Red, red, brown, gold.

d) Gray, green, orange, gold.

e) Brown, black, orange, gold.

f) Green, orange, orange, gold.

g) Brown, green, black, gold.

h) Blue, red, black, gold.

TEXT COMMENTARY

SOS PLANETA: el cambio climático amenaza la Tierra

La Cumbre del Clima de Montreal concluye que el efecto invernadero está teniendo gravísimas consecuencias en nuestro medio ambiente

Dicen los expertos que el cambio climático es la mayor amenaza medioambiental del siglo XXI, por lo que no es de extrañar la preocupación de los participantes en la Cumbre del Clima de Montreal por dar continuidad al Protocolo de Kioto una vez que, en 2012, se haya cumplido la primera fase de reducción de gases de efecto invernadero. El nuevo pacto involucra, por fin, a los Estados Unidos, que hasta ahora se habían negado a colaborar en el control del calentamiento artificial de la Tierra, a pesar de que este país, con el 5% de la población mundial, emite el 25% del total de gases con efecto invernadero.

Afectados por el cambio climático fueron desfilando cada día ante los 189 países que participaban en la cumbre. Todos tienen problemas, pero lo positivo de la cuestión es que, a raíz de sus preocupaciones, están surgiendo curiosas alianzas que intentan mitigar las trabas medioambientales. Los esquimales del Ártico, sin ir más lejos, se han unido con los pequeños estados insulares del Caribe y del Pacífico para recordar al mundo que ambos se están quedando sin modos de subsistencia: mientras a unos se les derrite el hielo bajo sus pies, los otros se ven cada día más inundados.

Las orcas son los animales más contaminados del Ártico

Además, el Ártico se está convirtiendo en un sumidero tóxico que está perjudicando tanto a su fauna y a su flora que podría extinguir algunas especies. Según el Fondo Mundial para la Naturaleza (WWF), hay tantas sustancias químicas en el agua que las orcas han superado a los osos polares en el triste «ranquing» de los animales con mayor carga tóxica del Ártico.

Teniendo en cuenta que la deforestación es la segunda causa del calentamiento global, por detrás de los combustibles fósiles, se han producido otras curiosas alianzas como las de los países de la selva tropical, encabezados por Costa Rica y Papúa Nueva Guinea. La llamada Coalición de los Bosques ha planteado al resto de países una aportación económica que les ayude a mantener sus bosques, sobre todo, teniendo en cuenta que en sus territorios se encuentran los verdaderos «pulmones» del planeta y que, sin estas ayudas, podría incrementarse aún más la velocidad a la que se desforesta.

El Panel Intergubernamental del Cambio Climático (IPCC) estima que una tercera parte de los bosques del mundo pueden quedar afectados por el cambio climático –especialmente, el bosque boreal o taiga del hemisferio Norte– y, con ellos, como eslabones de una cadena, los animales y las plantas que viven de ellos. Igual sucede en el medio acuático, donde la «calentura» del agua está matando a algunas especies y la sobreexplotación del ser humano está agotando nuestros mares.

TEXTO: **LOLA ESTEVA**
FOTO: **NASA**

Answer the following questions

1. The text mentions the greenhouse effect as the crux of the problem. Explain what it consists of.
2. The text talks about the Kyoto Protocol. What do you think it consists of?
3. The text mentions a series of problems that are appearing in the Arctic Army. Indicate what they are.
4. Similarly, in tropical countries problems of a different kind are emerging, although the causes are the same. State what these problems are.
5. The United States has never participated in the Kyoto Protocol, but its participation is essential for the protocol to be successful. Why is this so?
6. The text speaks of a series of alliances between peoples of different nature. Who are these peoples? What is their common objective?