UNIT 7

ENERGY

Index

1.Energy

2.Types of energy

3.Transformation and conservation of energy

4.Transferring energy.

5. Energy sources

1.ENERGY.

Energy is the capacity bodies have to produce changes in themselves and in other bodies.

The greater the energy possessed by a body, the greater the capacity it has to produce changes.

The unit of energy in the International System of Units is called the **joule.** This is in honour of the physicist James Prescott Joule (1818-1889). The symbol for this unit of measurement is **J.**

Sometimes, in addition to the joule, other units of energy are used, such as the **kilowatt per hour** (kWh) which we see on all our electricity bills.

1 kWh = 3 600 000 J

Energy is everywhere and energy is in everything

2. TYPES OF ENERGY.

Energy appears in various forms according to the type of change it produces. Some forms of energy are:

Kinetic (sound)
Potential (gravitational, strain)
Electrical (light)
Thermal
Chemical

Kinetic energy

In a bowling alley, which bowling ball will produce the greatest effect, the largest one or the smallest one? The one which goes slowly or the one which goes fast? The energy of the bowling ball and the effect it produces on the skittles depend on its mass and its velocity. This energy is called **kinetic energy.**

Kinetic energy (E_k) is possessed by bodies in motion.

Potential energy

The effect caused by a body when it falls to the ground will be greater when its mass and the height from which it falls are greater. The energy related to the position of a body is called **potential energy.**

Potential energy (E_p) is possessed by bodies due to the position they occupy in space or the deformation they are experiencing.

Let us have a look at two types of potential energy:

GRAVITATIONAL POTENTIAL ENERGY

The energy of a body at a certain height above the surface of the Earth is called **gravitational potential energy.**

ELASTIC POTENTIAL ENERGY

The energy of an elastic body when it is deformed is called **elastic potential energy.**

Electrical energy

The energy we consume in our homes is electrical and is propagated through conducting wires via the internal movement of charges.

Electrical energy is produced by the movement of charges in and through a conductor.

Electricity is generated in various types of power stations (thermal, nuclear, etc.) and is transported via high-voltage cables.

Internal and thermal energy

Matter is made up of many particles in motion which occupy specific positions. Each particle has kinetic and potential energies and the sum of all this energy is known as the **internal energy** of matter.

The **internal energy** of a body is the sum of all the kinetic and potential energies of the particles which form it.

When we only take into account the kinetic energy of these particles and not the potential energy, we are referring to **thermal energy**.

Chemical energy

Some materials such as coal, wood or oil store large quantities of chemical energy, which can be released through a chemical reaction.

Chemical energy is produced during chemical processes.

For example, through the combustion of natural gas, chemical energy is obtained in the form of heat and light.

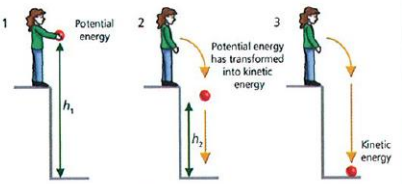
3. TRANSFORMATION AND CONSERVATION OF ENERGY

Imagine you dropped a ball from a specific height. Ignoring the friction caused by the air:

1 When the ball is at its highest point, its height (h_1) is at a maximum and its velocity is zero. The ball only has potential energy.

2 At some point during its fall, the ball has a height h_2 and is in motion. Its velocity is v. It has potential and kinetic energies.

3 When the ball reaches the ground, it does not have height ($h = 0$ m), but its velocity v is now at a maximum. It only has kinetic energy.



Conclusion: potential energy has transformed into kinetic energy.

We can see that the ball reaches a lower height on subsequent **bounces**. If we use a very precise thermometer to measure the temperature of the ball and the ground before and after bounces, we observe that the temperature of both has risen. So, when it bounces, part of the mechanical energy of the ball is transformed into heat.

In all these cases the energy is transformed from one form into another, but overall, it remains constant. This is one of the fundamental principles which explain the behaviour of energy: the **law of energy conservation**.

Energy cannot be created or destroyed, but it can be transformed.

4. TRANSFERRING ENERGY.

When energy moves from one object to another we say that energy is transferred.

There are two ways of transferring energy:

Heat and work.

Heat is when energy is transferred due to a gradient of temperature.

Work is when energy is transferred due to a force on an object when the force can move the object.

HEAT PROPAGATION

Heat is propagated when it passes from a hot body to a cold body. This process can happen in three ways: through conduction, convection or radiation.

Conduction

Kinetic theory explains why heat is transmitted through conduction between a hot body and a conducting material which is in contact with it.

The particles in a hot body, with greater kinetic energy, transmit part of their thermal agitation to the particles of the conducting substance which is in contact with. This agitation passes from some particles to their neighbours, until the entire body of the conductor is affected. The speed of this process is greater when the temperature difference between the two bodies is greater.

Conduction is the way in which heat propagates between two points of a body, generally solid, which are at different temperatures, without a movement of matter.

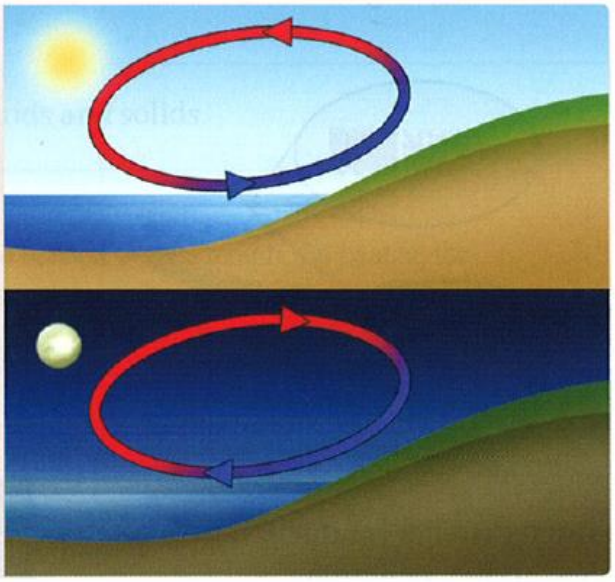
Convection

Convection is the way in which heat is propagated in fluids (liquids and gases). In these, heat is propagated in the form of currents, which are called **convection currents** and are produced until the temperature is the same throughout the liquid.

In coastal regions, the sea breeze has a modifying effect on temperatures thanks to convection currents. Therefore, in the summer the process which is represented in the diagram is produced.

During the day, the land is at a higher temperature than the water, so the air which has been heated rises above the land and is displaced towards the sea. The air from the sea, which is colder, occupies its place over the land: this is the sea breeze.

During the night, the land cools before the sea, so the air over the sea is warmer. This air rises and is displaced towards the land: the nocturnal air currents go in the opposite direction to those during the day.



Radiation

Radiation is the only form of energy transmission which is produced from the surface of bodies through a vacuum or material medium in the form of electromagnetic waves.

Radiation is not exclusive to the Sun; any body can radiate energy. This radiation is greater when the surface area and the temperature are greater.

5-ENERGY SOURCES

Nowadays, in the majority of industrial processes and in the domestic environment, the use of electrical energy is essential.

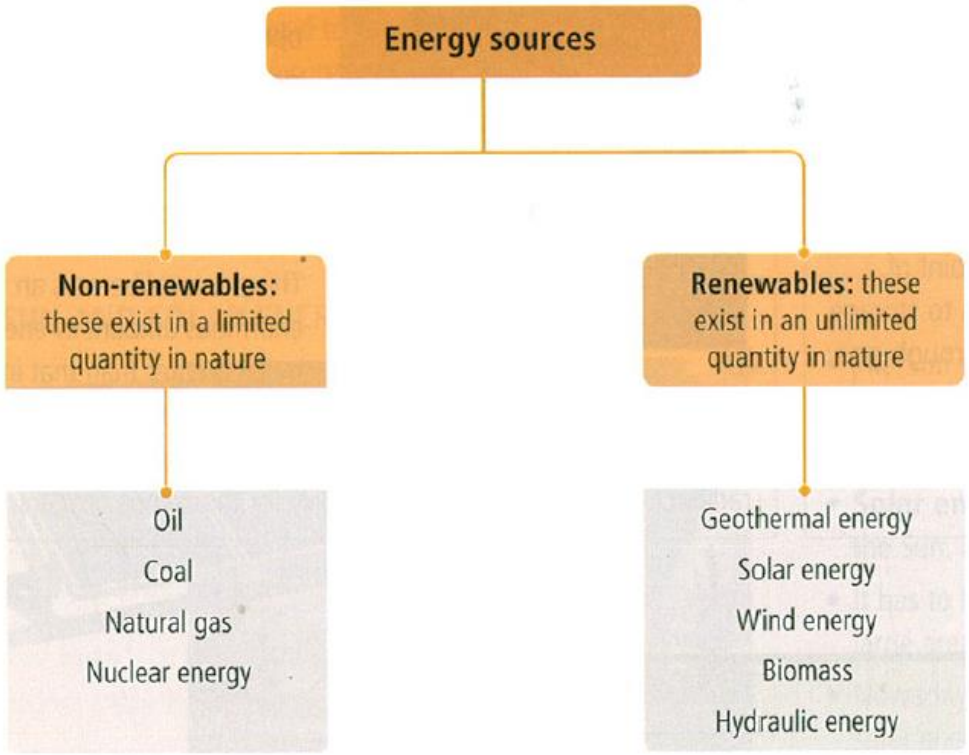
At home, household appliances, mobile phones, computers, heating and lighting depend on electricity. In addition, any manufacturing process continuously uses electricity. In transport, electrical energy is also used, as well as the energy from fuels, but where does this energy come from?

Electrical energy, as it is easy to transport and transform, is the most used energy in our daily lives. This is obtained from a series of energy sources or energy resources.

An **energy source** allows us to produce energy directly or through some transformation.

There are many types of energy sources, but we can classify them into:

- **Renewable energy sources**: these are easily regenerated and are **inexhaustible**.
- **Non-renewable energy sources**: these are consumed at faster rate than they are generated in nature.



Non renewable energy sources:

Non-renewable energy sources come from **deposits**. Therefore, they are found in **limited amounts** and their reserves run out as they are consumed.

Contemporary societies suffer from an enormous dependence on non-renewable energy sources. However, its use has a large impact on the environment.

COAL

A solid black fossil fuel formed by the accumulation of vegetable matter underground over thousands of years. It contains large quantities of carbon.

It has high calorific power, but it is expensive to extract.

It is used as a fuel in thermoelectric electricity generation plants or **thermal power stations**. However, the use of this fuel in these power stations is highly polluting.

OIL

A liquid fossil fuel with a dark colour and a strong smell made up of a mixture of organic compounds called hydrocarbons, originating from the decomposition of animal and vegetable matter.

It is used as a fuel in thermal power stations to generate **electricity**.

It is also used as a raw material in manufacturing **fuels** (petrol, diesel, etc.) and a multitude of other products (**plastic**, rubbers, etc.). Its price has an enormous influence on the world's economy.

NATURAL GAS

A fossil fuel made up of, above all, methane (CH_4). It is used as a fuel, both in industry and at home.

It is transported from its point of extraction to storage centres through **gas pipelines.**

It is used as a fuel in electricity generation plants, being more efficient than other fuels.

URANIUM AND NUCLEAR ENERGY

A radioactive chemical element which is used as a fuel to obtain electricity in **nuclear power stations**. There, the uranium atoms **undergo** fission. In other words, they are split into lighter atoms.

This process liberates an enormous amount of energy, much greater than that in the combustion of oil, gas or coal. However, it **entails** serious risk due to the possibility of radioactive leaks and because it generates radioactive waste which remains active for thousands of years.

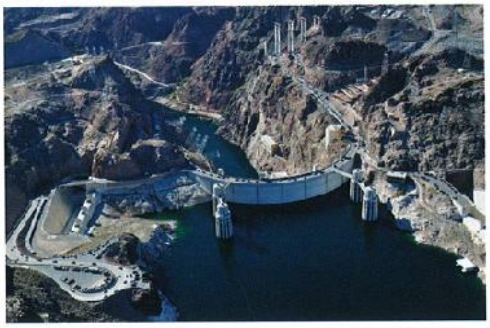
Renewable energy sources:

The energy from renewable sources comes from the Earth's inexhaustible resources, such as the Sun, water or wind.

THE SEA AND TIDAL ENERGY

- The sea, which is continuously moving, provides an inexhaustible energy source.
- **Tidal energy** uses the movement of the waves and **tides** to produce electrical energy by moving generators.
- There are currently various projects to use energy from the sea through the use of currents or using the difference in temperature and salinity between the various layers of seawater.
- On the whole, the use of this energy source is not common as building and maintaining its installations is problematic.

WATER AND HYDRAULIC ENERGY



- Water is an inexhaustible resource.
- **Hydraulic energy** comes from the potential energy of water stored at a height. When it falls, the potential energy is transformed into kinetic energy and through a mechanical process, it is then transformed into electrical energy. This water is stored using **dams** and **reservoirs**, and comes from rivers, rain and snow melting.
- Hydraulic energy is clean, as it does not generate waste, and the stored water can be used to supply the population, for **irrigation** and even for leisure activities.
- The power station must be built at a suitable location on the bank of a large river at a great height. Transporting this energy to centres of consumption is expensive.

WIND AND WIND ENERGY

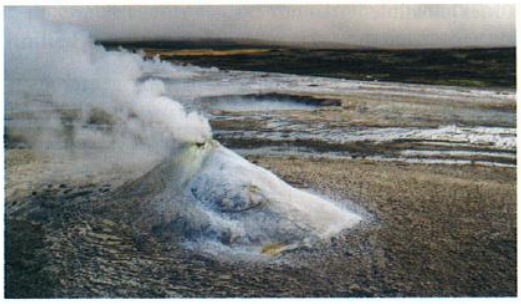
- Wind is an inexhaustible resource which is very strong in some areas.
- **Wind energy** is the energy produced by wind and is clean.
- Wind energy is generated in the following way: the kinetic energy of wind is transmitted to the wind turbine, which converts this kinetic energy into electrical energy through a mechanical process.
- It is an intermittent energy because it depends on the availability of wind at that time. As a result, wind farms are built in places where there is as much continuous strong wind as possible.

THE SUN AND SOLAR ENERGY

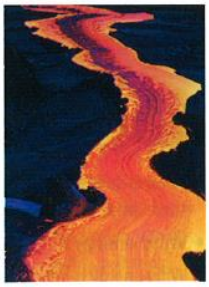
Photovoltaic solar panel (a) and thermal solar panel (b)

- The Sun is an inexhaustible resource which is present across the whole planet. This energy source is used in solar power stations.
- **Solar energy** comes to the Earth in the form of radiation from the Sun. It is a clean, inexhaustible, free and high-quality energy.
- It has to be transformed into electricity and heat, and requires large areas to store it.
- Nowadays, solar energy is used in two different ways: thermal solar energy, which collects the Sun's thermal energy in a liquid form, and photovoltaic solar energy, which transforms solar radiation into electrical energy.

GROUND HEAT AND GEOTHERMAL ENERGY



- The heat which comes from inside the Earth shows itself in the form of volcanoes, **fumaroles**, geysers and thermal springs.
- **Geothermal energy** originates from inside the Earth in the form of heat. It is only used in those places where there are thermal reserves.
- It is clean.



BIOMASS

- Biomass comes from agricultural, forestry, livestock and some solid urban waste.
- Its combustion can be used in the form of thermal or electrical energy.
- It supplies energy continuously and saves on waste elimination.
- Biomass can be used in a domestic environment (for example, in boilers), but also in **biofuel production centres or thermal power stations**.

UNIT 6
ACTIVITIES

A1-

The name of each form of energy starts with an adjective. For example:

kinetic energy

The word 'kinetic' is an adjective which describes the noun 'energy'. Kinetic is a term which means 'related to movement'.

1 Here are ten words used to name forms of energy. First, you will have to separate the words in the string. Write the words in the spaces below. (The last one is a phrase of two words.) The first one has been done for you.

kinetic/thermalchemicalstrain electricalgravitationalpotential

..... kinetic ..... energy

..... energy

..... energy

..... energy

..... energy

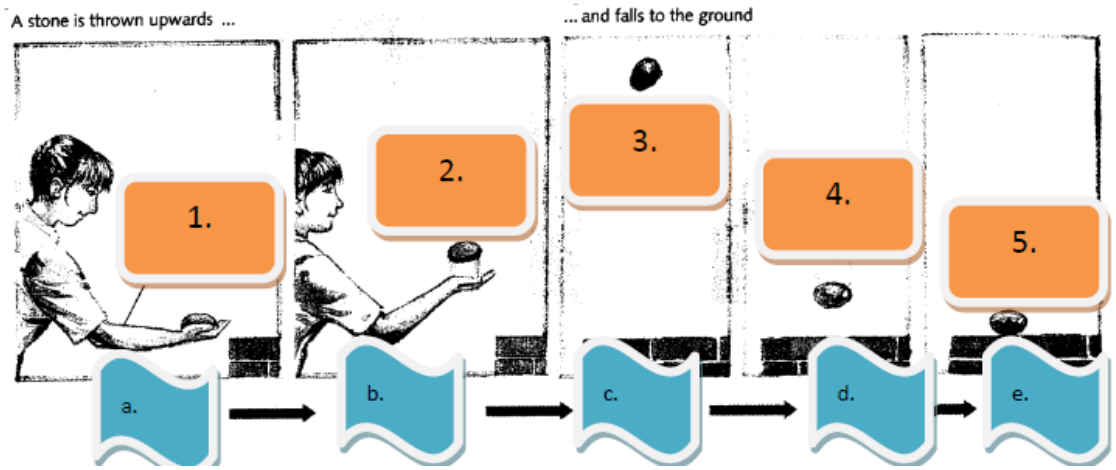
..... energy

..... energy

2 The table below contains descriptions of six forms of energy. Complete the table by writing the name of each form in the first column. The first one has been done for you.

	Form of energy	Description
	kinetic energy	is the energy of a moving object
a		is energy released in a chemical reaction
b		is energy stored in a hot object
c		is energy stored when an object is pushed upwards
d		is energy moving around an electric circuit
e		is energy released in a reaction

A2-Energy transformation



A. The following are the steps of the sequence from the moment the stone is thrown upwards until it falls to the ground. Write the numbers of the pictures above next to the corresponding step.

Stone at highest point	◯	Stone hits wall	◯
Stone moves upwards	◯	Stone falls to the ground	◯
Energy stored in muscles	◯		

B. Now, write the form of energy below each picture.

chemical kinetic kinetic potential thermal

C. Order these sentences from the text and translate them into Spanish.

1. transformed. energy is from one form to say changes another, scientists that energy When

2. To you do have to energy. work, spend

3. Energy cannot be or but it can change form destroyed, from one form to another. made

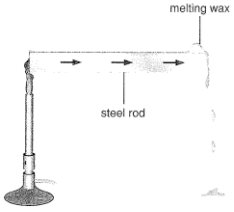
A3-

Heat transfer – interpreting diagrams

Diagrams are useful because they can summarise information and ideas. In this exercise, you will interpret (draw conclusions from) three diagrams which show the three different mechanisms of thermal (heat) energy transfer.

Conduction, convection and radiation – these are the three mechanisms by which energy is transferred from a hot place to a cold place. We call these thermal energy transfers or heat energy transfers. For each of the three diagrams, state which mechanism it represents, explain how you know, and state what the arrows in the diagrams represent.

Mechanism 1



1 Which mechanism does this represent – conduction, convection or radiation?

.....

2 Explain how you know.

.....

.....

3 What do the arrows in the diagram represent?

.....

.....

Mechanism 2

4 Which mechanism does this represent – conduction, convection or radiation?

.....

5 Explain how you know.

.....

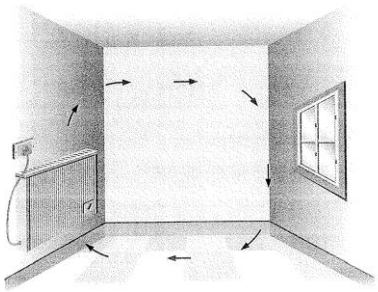
.....

6 What do the arrows in the diagram represent?

.....

.....

Mechanism 3



7 Which mechanism does this represent – conduction, convection or radiation?

.....

8 Explain how you know.

.....

.....

9 What do the arrows in the diagram represent?

.....

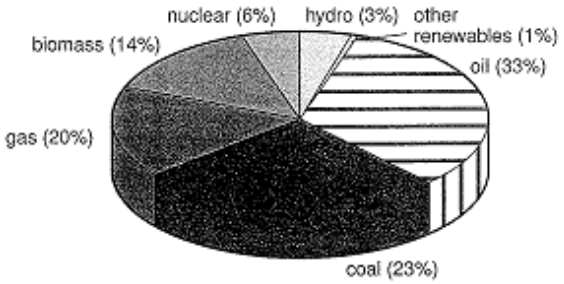
.....

A4-

Where we get our energy from

People use energy for many different things – heating, lighting, operating machines, transport and so on. We use many different energy resources. In this exercise, you will interpret information provided in a pie chart.

The pie chart shows the different energy resources used by people around the world. Each sector of the chart shows the contribution of an energy resource.



Biomass is the common name for organic materials that can be used as renewable energy sources such as wood, plant matter and crops.

Study the chart and decide if each of the following statements is correct or incorrect. If you think the statement is incorrect, cross out the words that are wrong and write the correction on the line below. Here is an example to help you:

We use ~~less~~ coal than biomass.

..... more .....

a The energy resource we use the most is oil.

.....

b We use more gas than coal.

.....

c We use twice as much hydro as nuclear.

.....

Write sentences of your own using these phrases, together with information from the pie chart. Your sentences must all be correct!

a less … than

.....

.....

b more … than

.....

.....

c as much … as

.....

.....

d the most

.....

.....

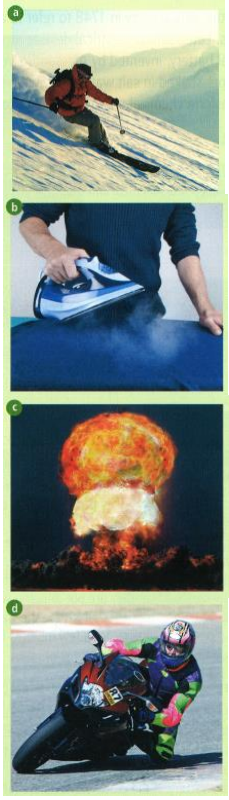
e the least

.....

.....

UNIT 7
EXERCISES

1	Identify what type of energy is stored in: Natural gas An electric heater The wind A horse in a race A light bulb A fly on the ceiling

2	When you have cold hands and you rub them together, what energy transformation takes place?
3	Identify what energy transformation takes place when you turn on an oven and food is heated
4	What does temperature measure? What measuring instrument can be used?
5	Match each picture with the corresponding energy transformation:  1. Nuclear to thermal energy. 2. Electrical to thermal energy. 3. Chemical to kinetic energy. 4. Potential to kinetic energy.
6	What type of material is a blanket, a conductor of heat or an insulator?

7	Explain why a coat made of wool protects us from the cold. Would a darker or a lighter coloured coat protect us from the cold more.
8	Which mechanism of heat propagation leads to the displacement of the mass of the substance being heated?
9	How is air conditioning propagated, through conduction, convection or radiation.
10	match each energy with its characteristic: a. Wind energy. 1. It is only found in some places of the planet. b. Hydraulic energy. 2. It needs large areas to be stored. c. Solar energy. 3. It must be located next to a river. d. Geothermal energy. 4. It is an intermittent energy.