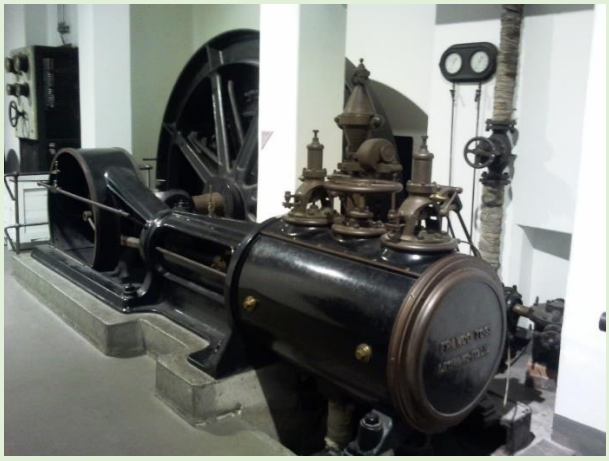
COMBUSTION ENGINES:PART 1

COMBUSTION ENGINES. INTRODUCTION.



STUDENT' WORKSHEET

Names:		Surnames:		Group:	Qualification
				Date:	

COMBUSTION ENGINES. PART 1.
COMBUSTION ENGINES. INTRODUCTION.

Introductory text

After the Industrial Revolution, we don't conceive the world without combustion engines. Combustion engines have allowed easier and less time to move. They have also made it possible to produce more products, more economically, sometimes with better quality, more quickly, reducing the price and so, allowing to be bought for everyone. In general, they have contributed to a very important advance in our society, reaching the society we know now.

However, combustion is a chemical reaction that emits certain gases into the atmosphere and which may have harmful effects on our environment.

The combustion engines can be classified into external and internal combustion engines.

In this scenario, we are going to learn lot of things about external combustion engines. Let's go!!!

INFORMATION ABOUT ACTIVITIES:

Individual activity

Work in pairs

Work in groups of three

Work in groups of four

PREVIOUS ACTIVITY (SELF-ASSESSMENT ACTIVITY)

Previous activity (*13 Points*) To know your previous knowledge, choose the best answer for these questions. If the questions can have more than one possible answer (indicated) choose all of them. If it isn't indicated, and there is more than one correct answer, choose the best one). At the end of the activity, you will know the correct answers. Each correct answer: 1 point. If you don't find the response, don't worry, it's just to know your previous knowledge.

1. Which of the following environmental problems can increase due to the burning (combustion reaction) of fossil fuels? (More than one possible answer)
    a. Acid rain.
    b. Ozone hole.
    c. Global warming.
    d. Radioactivity.

2. Some products that could we get in a real fossil fuels' combustion reaction are: (More than one possible answer)

    a. Carbon dioxide.
    b. Water (steam).
    c. Heat.
    d. Uranium.
    e. Radioactivity.
    f. Sulphur oxides.
    g. Nitrogen oxides.
    h. Carbon monoxide.

3. An external combustion engine could be: (More than one possible answer)

    a. A wind turbine.
    b. A solar cell.
    c. A steam engine.
    d. A car engine.
    e. A steam turbine.
    f. A turbofan (plane engine).

4. A steam engine has been used in: (More than one possible answer)
    a. Industries such as textile industries.
    b. Car engines.
    c. Steam trains.
    d. Electric trains.
    e. Power stations to obtain electricity.

CORRECT ANSWERS (each correct answer 1 point; some have more than one point. Maximum 13 points):

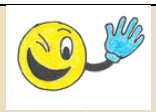
1: **a, c**

2. **a, b, c, f, g, h**

3. **c, e**

4. **a, c, e**

FINAL SCORE (PREVIOUS KNOLEDGE)

			
Less than 2 correct answers	3-5correct answers	6-9 correct answers	10-13 correct answers
COULD BE BETTER	**SATISFACTORY**	**GOOD**	**YOU ARE AN COMBUSTION ENGINES EXPERT**

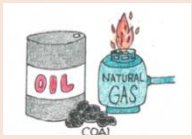
Combustion reaction

Energy is essential in our life. Energy can be used to heat, to light, to power engines and computers, etc. Energy is something that can do work. According to the "**Law of *Conservation of Energy***", energy can't be created or destroyed, it can only be transformed. For instance, when wood burns, the chemical energy stored in wood is transformed into heat.

When anything is burnt, a chemical reaction called ***combustion*** takes place. This reaction is almost always an exothermic reaction (the reaction gives heat). Combustion reactions need the presence of molecular oxygen O_2.

Combustion reaction

Most materials that combust are organic (they are made up of carbon, hydrogen and oxygen). ***Hydrocarbons*** are chemical compounds made by hydrogen, carbon and other components, which combust in the presence of oxygen.

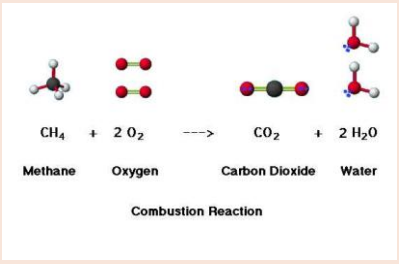


Fossil fuels are examples of hydrocarbons

In a complete combustion reaction, the organic molecules combust producing carbon dioxide, water and heat.

ORGANIC MOLECULES with (C, H and O) + O_2 ⟶ CO_2 + H_2O + HEAT

Example of a **complete combustion reaction**: Methane:



+ ENERGY

Activity 1 ***(13 Points)*** *After* reading the text '*Combustion reaction'*, answer the questions below:

1. (3 Points) Write three uses of energy:
2. (2 Points) The "Law of Conservation of Energy" states that …
3. (2 Points) What is a combustion reaction?
4. (1 Point) Which molecule does the combustion reaction need to burn a hydrocarbon?
5. (2 Points) What is a hydrocarbon?
6. (3 Points) Which products are produced in a complete combustion reaction?

Activity 2 ***(7 Points: 4 correct answers and 3 corrections)***. Write a cross in the correct box to indicate whether the following statements are true or false according to the text on ***Activity 1***. Correct the false sentences.

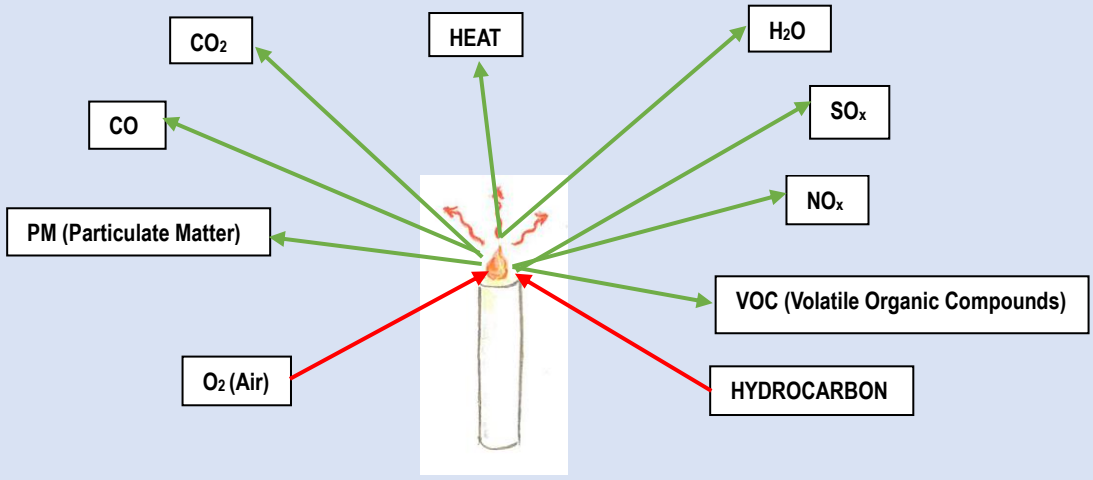
SENTENCE	TRUE	FALSE
1. Combustion reaction needs the molecule of nitrogen.		
2. An exothermic reaction produces energy (heat).		
3. A hydrocarbon is always composed of hydrogen, nitrogen and oxygen.		
4. Complete combustion reactions produce: water, carbon monoxide and heat.		

Corrections (***just in case***):

1.
2.
3.
4.

Activity 3 ***(9 Points)*** Fill in the gap (in the text "*A real combustion reaction*") with a word from the box below, as in the example (**air**). Careful! There are more words than gaps!!

Real combustion reaction



Real combustion reaction

Hydrocarbons used are not pure hydrocarbons and combustion with **air** (no Oxygen). When a pure _____ is burnt with oxygen it releases heat, _____ dioxide and _____. Carbon dioxide is a greenhouse gas which increases global warming. However, fuels such as coal and oil are not pure hydrocarbons, they contain other substances too. For example, coal contains sulphur. When coal is burnt, the _____ reacts with air to form sulphur dioxide, one of the chemical compounds which causes _____ rain. Therefore, complete combustion is almost _____ to achieve. In fact, as actual _____ reactions come to equilibrium, a wide variety of major and minor species would be present, such as carbon monoxide, pure carbon, volatile organic compounds, particulate matter, etc.. Bad combustions generate substances which in areas without sufficient ventilation produce chemical fog, quite dangerous for the health (respiratory problems). Additionally, any combustion in _____air, which is 78% nitrogen, will also create several forms of _____ oxides producing acid rain in contact with atmospheric water.

Hydrocarbons + Air ⟹ CO_2 + H_2O + HEAT + SOx + NOx + Other products (CO, VOC; PM ...)

SO_X (sulphur oxides) ⟶ Fossil fuel (sulphur from earth)
NO_X (nitrogen oxides) ⟶ Combustion with air (78% of Nitrogen)
Other products (CO, Particulates matter, volatile organic compounds, etc.) ⟶ Bad combustions

hydrocarbon	impossible	nitrogen	**air**	petrol	acid
atmospheric	water	combustion	carbon	greenhouse	sulphur

 **Activity 4** (***10 Points***) We are going to build a wiki about the environmental and health problems due to the combustion reactions. Select one of the products that could appear in a real combustion reaction (carbon dioxide, sulphur oxides, nitrogen oxides, carbon monoxide, volatile organic compounds, particulate matter) and search for some information on the net about the causes and the effects that, the selected product, can produce in our environment or in our health. Write a description with the obtained information. You can follow the examples proposed. You should add more information because you will find just some examples. (Some texts are adapted from Wikipedia).

Some grammar help:

DEFINING				
…..	is/was a/an are/were	(generic term) place person thing concept entity device instrument tool etc	where who which that	…..

MAKING DESCRIPTIONS

Talking about …

First of all, define what is that you are talking about and where it comes from:

This is a … It comes from …

Then describe its appearance, structure, etc:

It has … It looks like … It has a ... It is made up of … It hasn't got …

Describe the location:

It is found in …

Describe the function:

… has the job of …-ing (verb ending in ing) …

It also does …

Activity 5 (***10 Points***) Oral presentation. Explain to your partners, the product obtained from a combustion reaction chosen in the previous activity. You should use some ICT tools (PowerPoint or similar) to help you in the oral presentation.

Some advices for the oral presentation:

Start the presentation introducing yourself and the purpose of the oral presentation (introduction).

Explain it (main body).

Try to keep the maximum order in the presentation.

Speak clearly and without rush (not fast).

Try to avoid "dead spaces" (no words for a period of time)

Look at the listeners as much as possible. Eye contact is important. Project the voice as well.

Control your volume, tone, speed and pauses during the presentation. Modify the tone of speech, gesticulate and move a little (not too much).

Show security of what you say.

Smile.

Try not to be very nervous.

Keep it short and simple (KISS). Don't give too much information. Be clear and concise.

Practice previously the presentation at home, with any person you know and with your partners.

Study the parts that each student is going to present according to their skills. Work in groups.

Control the time.

Tell the audience what you have said (summary).

When you finish the presentation, ask for attendees if they have any doubts and when you resolve them, thanks them for the attention and say goodbye.

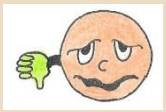
If you use ICT tools (PowerPoints or similar):

- Put short sentences and little text (must serve just as a guide). Just key sentences/words.
- Use images.
- Try not to read what appears in presentations and don't talk to the visual.

Language for oral presentations:

1. Beginning:
   - Good morning, everyone. My/our name is/are ….
   - In my/our presentation today, I'm/We're going to look at/describe …
   - To begin with, I'll/We'll introduce …
   - I'd/We'd then ...
   - If you have any questions, I'll/we'll be happy to answer them at the end.
2. Moving on:
   - So, to begin with, let's look at …
   - Right, let's start by looking at …
   - Ok, having looked at the background information, I'd/We'd now like to move on to …
   - Right, now that the scene has been set, I'd/We'd now like to focus on …
3. Linking phrases:
   - Next, I'd/We'd like to look at …
   - Firstly, …
   - This leads to my next point …
   - Closely linked to this is the issue of …
4. Moving on:
   - In the final part of my/our presentation, I'd/We'd like to …
5. Summarising:
   - So, to sum up, we've looked at …
6. The ending:
   - That concludes my/our presentation. Are there any questions?
   - That brings us to the end of my presentation. Thank you very much for listening. Does anyone have any questions?
   - If anyone has any questions. I'll/we'll do my/our best to answer them.
7. Dealing with questions:
   - That's an interesting one.
   - I'd/We'd to answer that in two parts …
   - Well, the question is ……. Is that right?
   - Does that answer your question?

Peer assessment. Assess the oral presentation of your partners (*one for each partner/oral presentation*). Put a tick in the right columns in the grid below.
Your name: _____ Product (thing) selected: _____

Your name: Product (thing) selected: YOUR PARTNER'S NAME:	What to evaluate:				
		COULD BE BETTER 1	**SATISFACTORY 2**	**GOOD 3**	**VERY GOOD 4**
	English level				
	Easy to understand				
	Adequate vocabulary				
	Interesting oral presentation				
	Speak clearly				
	ICT used quality				
	Remember the information?				
	Dynamic oral presentation				
	Change the voice tone				
	Is self-confident enough?				
TOTAL					**/40**

Activity 6 OPTIONAL ACTIVITY. ROLE PLAY ACTIVITY (10 Points) You are going to take part in a role-play between different members of a United Nations committee. You will be discussing the greenhouse effect. There are six people on this committee and each person has specialist knowledge on the greenhouse effect, together with strong ideas and opinions. Your role-play character's name appears at the top of the paper. Read your role carefully, and then make a list of the main views and concerns of your character. Try to remember these. Elect a chairperson for each group. The chairperson will start the discussion with everybody introducing themselves to the group (name, who they work for, etc.) and giving their thoughts on the greenhouse effect. Each person can then say with whom they agree or disagree, giving reasons why. You can use the HELP below.

Characters activity 6

Mr A. Overmaier/Ms G. Answalliest Atmosphere science expert from Germany. You have worries about the amount of carbon dioxide released into the atmosphere. You believe that as more fossil fuels are burnt, more carbon dioxide is produced, increasing the greenhouse effect on Earth. This produces global warming and climate changes. In your opinion it is absolutely crucial to burn less fossil fuel to preserve our planet. Regarding the use of electricity in cars, in order to produce more electricity we need more power stations, meaning the need for more fossil fuels being burnt or more nuclear power stations.	**Mr J. Pauco/Ms V. Chavez** Economic consultant for the government of Venezuela. You are interested in improving the lifestyle conditions of the people who live in your country (with several economic problems). You propose to extract more oil and to cut down more trees (to build better roads) in order to develop your country. In fact, these are your country's natural resources, and it is the only means of living for some people. Additionally, it is not so clear any more that the climate change is due to the use of fossil fuels.
Ms G. MacQuins/Mr. Lutwick President of the World Association of Car Manufacturers You want to protect your industry and, therefore, you don't want neither to reduce the number of cars made by the car industry, nor to be forced to increase prices. Car companies spend lots of money in an attempt to reduce pollutants and fuel consumption in their vehicles. In your opinion, the problem of pollution is being solved, as they are proposing the use of hybrid engines (combustion and electric engines working together) and electric cars. More and more, some studies carried out in USA show climate is not changing.	**Ms I. Ringston/Mr. O. Prowning** Expert geologist working for a prestigious American university. In your opinion there is just a small quantity of fossil fuel remaining inside the Earth, and it is necessary to stop extracting the oil in the current amount of barrels. The fossil fuel can't be regenerated easily, so it is necessary to preserve the existing oil reserves. Furthermore, there have been many environmental disasters as a result of the extraction and transport of fuel. It's necessary to use alternative energy resources such as (wind or solar energy). Regarding cars, you propose the use of electric engines.
Ms C. Khayat/Mr O. Khalifa Specialist in Environmental problems. Your studies show that the level of oxygen (an essential gas in animal life) is decreasing each year, mainly because of the use of oxygen to burn fossil fuels. This oxygen is not easily regenerated. Furthermore, some countries are cutting down trees (producing deforestation). Trees and vegetation increase atmospheric oxygen through photosynthesis. Other concerns include environmental disasters due to the extraction and transport of fuel.	**M. P. Chevalier/Ms E. Roquineur** Expert French chemist. You don't think carbon dioxide released into the atmosphere is a problem, as this gas can dissolve in sea water. However, given your experience as a chemist, you know that combustion (mainly from petrol engines) produces other gases which have an influence on the greenhouse effect and on the acid rain. These cannot be absorbed easily by the sea. In your opinion, all the cars should have catalytic converters to avoid the production of these gases, adding over 500 € to the cost of a car. Another option would be for car companies to manufacture more hybrid or electric cars.

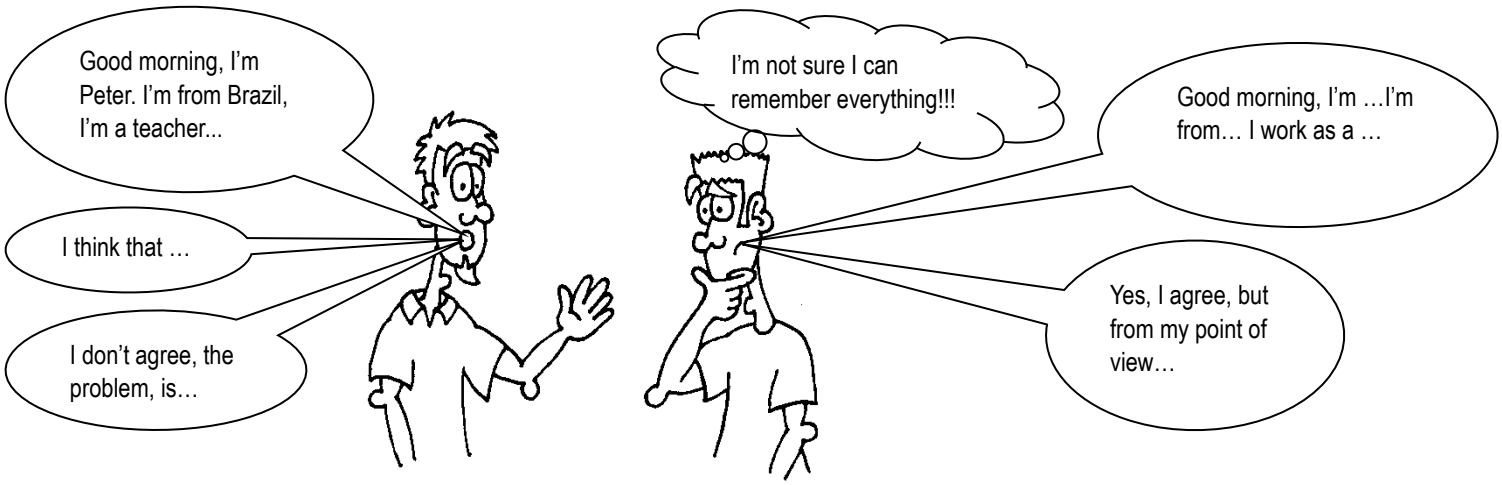
Adapted from: Sheffield City Polytechnic/Collins Educational 1992. Active Teaching and Learning Approaches in Science

HELP ACTIVITY 6 (ROLE PLAY)

GIVING OPINIONS	**INTRODUCING YOURSELF**		
What do you think about…? What is your opinion about …? Why do/does/did …? In my opinion … From my point of view … I think … I would answer …. I think so. I don't think so. I agree. I don't agree. I disagree. Give me a reason for that.	Hello, Good morning,	My name is ...	I' m ... I'm from ... I wok in/as ...

DEFINING				
…..	is (a) are was/were	place, person thing, concept device instrument, tool, designed, build	(where) (who) (which) (that)	…..

RELATION CAUSE-EFFECT. GIVING REASONS	**COMPARING AND CONTRASTING (For differences)**
as a result because for example, for instance so that is why such as	in contrast compared with/in comparison with … is different from … (in that …) on the one hand/on the other hand however/otherwise … differs from … in respects: (firstly, secondly, finally,) from a different point of view/perspective



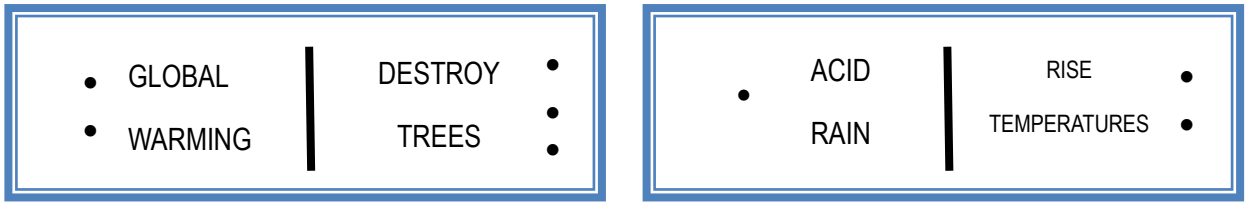
ACTIVITY 7 *OPTIONAL* ACTIVITY. DOMINO GAME (10 Points) *(Adapted from "Active Teaching and Learning Approaches in Science", Centre for Science Education, Sheffield City Polytechnic.)*

RULES:

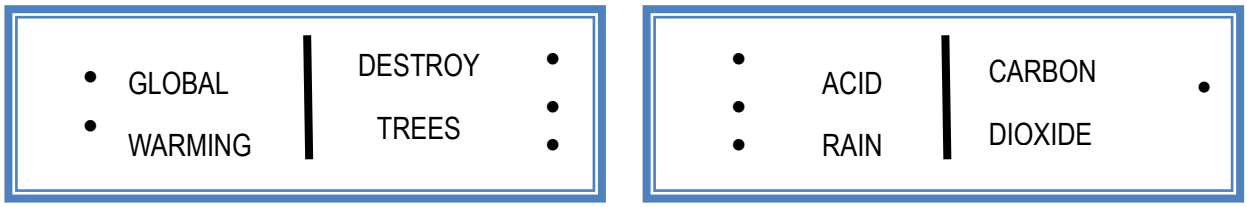
1. The game is for two or four players.
2. 20 pieces of domino are shared amongst the students. Each student must have the same amount of pieces.
3. One student starts by laying any domino down, face up.
4. The player to the left plays the next domino so that the Environmental Problems due to the Combustion of Fossil Fuels on the new domino matches with the cause that produces it on the previous domino.
5. The game continues with players matching the dominoes in their hand with the dominoes that have already been laid.
6. If a player cannot match a domino they must say "Pass" and allow the player on their left to continue the game.
7. The game continues in this way until one player has played all their dominoes.
8. Any player may challenge another player if they think the pieces don't match.
9. The game can also finish when there are no more possibilities to match pieces.
10. The match should be checked by the teacher, and if the match is wrong the player who laid the wrong domino loses three points. If the match is correct then the player who made the challenge loses three points.
11. The player with more points will get a score of 10, the second 9, etc.

SCORING:

A. Every time two dominoes match, the player adds up the total of dots shown on the matching pieces.
Example: Destroy trees (3 dots) matches with Acid rain (1 dot); Score: 3+1 = 4 points.



B. If a player matches two pieces with the same number of dots, the total score will be the double of the number of dots:
Example: Destroy tress (3 dots) matches with Acid rain (3 dots); Total score 2·(3+3) = 12



C. The player who lay down all their pieces first will receive 10 extra points.

DOMINO


GLOBAL WARMING
DESTROY TREES
ACID RAIN
CARBON DIOXIDE
GLOBAL WARMING
RESPIRATORY PROBLEMS
CHEMICAL FOG
GREENHOUSE EFFECT
GLOBAL WARMING
DAMAGE BUILDINGS
ACID RAIN
LETHAL GAS
CARBON MONOXIDE
SULPHUR OXIDES
ACID RAIN
RISE TEMPERATURES
GLOBAL WARMING
FISHES DIE
ACID RAIN
NITROGEN OXIDES
ACID RAIN
LESS ICE IN NORTH POLE
GLOBAL WARMING
FOG WITH COMPONENTS SUSPECTED TO BE CARCINOGENS
CHEMICAL FOG
REPLACE THE BLOOD OXYGEN
CARBON MONOXIDE
PARTICULATE MATTER
CHEMICAL FOG
CAN DESTROY FORESTS IN COUNTRIES WHICH DON'T PRODUCE IT
ACID RAIN
MORE OR LESS RAIN IN SOME PARTS OF THE WORLD
GLOBAL WARMING
PLANTS CAN'T LIVE BECAUSE THE QUALITY OF SOIL
ACID RAIN
FOG DUE TO BAD COMBUSTIONS
CHEMICAL FOG
COMBUSTION WITH AIR
ACID RAIN
CAN PRODUCE MORE HURRICANES

Combustion engines classification

An engine, or motor, is a machine that converts one form of energy into mechanical energy (movement) that can be used to produce an action. The energy can be in any form. Common forms of energy used in engines are electricity, chemical (such as petrol or diesel) or heat. For example, an electric engine is a machine that transforms electricity into movement. When an engine uses a fuel, producing mechanical energy from a combustion reaction, it's called combustion engine. This combustion reaction can take place outside the engine (external combustion engine) or inside the engine (internal combustion engine).

External combustion engines

1. **Steam engines**

They started to be used about 300 years ago. In a chamber outside the engine called the boiler (or furnace), fossil fuels were burned to boil water, resulting in the production of steam. Since steam takes up to 1,500 times more space than water, the pressure generated could be used to move a piston, transforming heat energy into mechanical energy (movement). It was used in industry (for instance the textile industry) in the 19th and the first half of the 20th centuries. It was used in steam trains and in steam boats as well.

2. **Steam turbines**

Steam turbines transform pressurized steam, turning its blades in a rotation movement. This rotation movement is generally used to generate electricity. It is used in electric power stations.

Internal combustion engines

1. Piston engines (Reciprocating engines)

Fossil fuel combustion (usually the fuel is in gas or vaporized liquid state) is produced inside the engine and the explosion achieved, and gases that appear, are used to move a piston with a lineal and repetitive up-and-down or back-and-forward motion.

1.1. ***Spark-ignition engines***. Engines that need a spark (produced by the spark plug) to produce the combustion reaction.

1.1.1. The four-stroke engine: Nikolaus Otto, a German engineer, designed the four-stroke engine in 1876. (Following the thermodynamic cycle with his name (Otto)). A four-stroke engine completes the thermodynamic cycle in four movements of the piston (between the moment in which petrol come inside the cylinder and it is repeated this action, piston has four movements); for this reason, is called four-stroke engine. Use petrol as a combustible. Used in the most of the petrol cars.

1.1.2. The two-stroke engine: Dugald Clerk, a Scottish engineer, is thought to have invented the 2-stroke engine in 1878 and in 1881 patented his design. The two-stroke engines follow the Otto thermodynamic cycle as well, but this engine complete the cycle in two movements of the piston; for this reason, is called two-stroke engine. Two-stroke engines require a specific oil to gas ratio. It is used in some motorbikes.

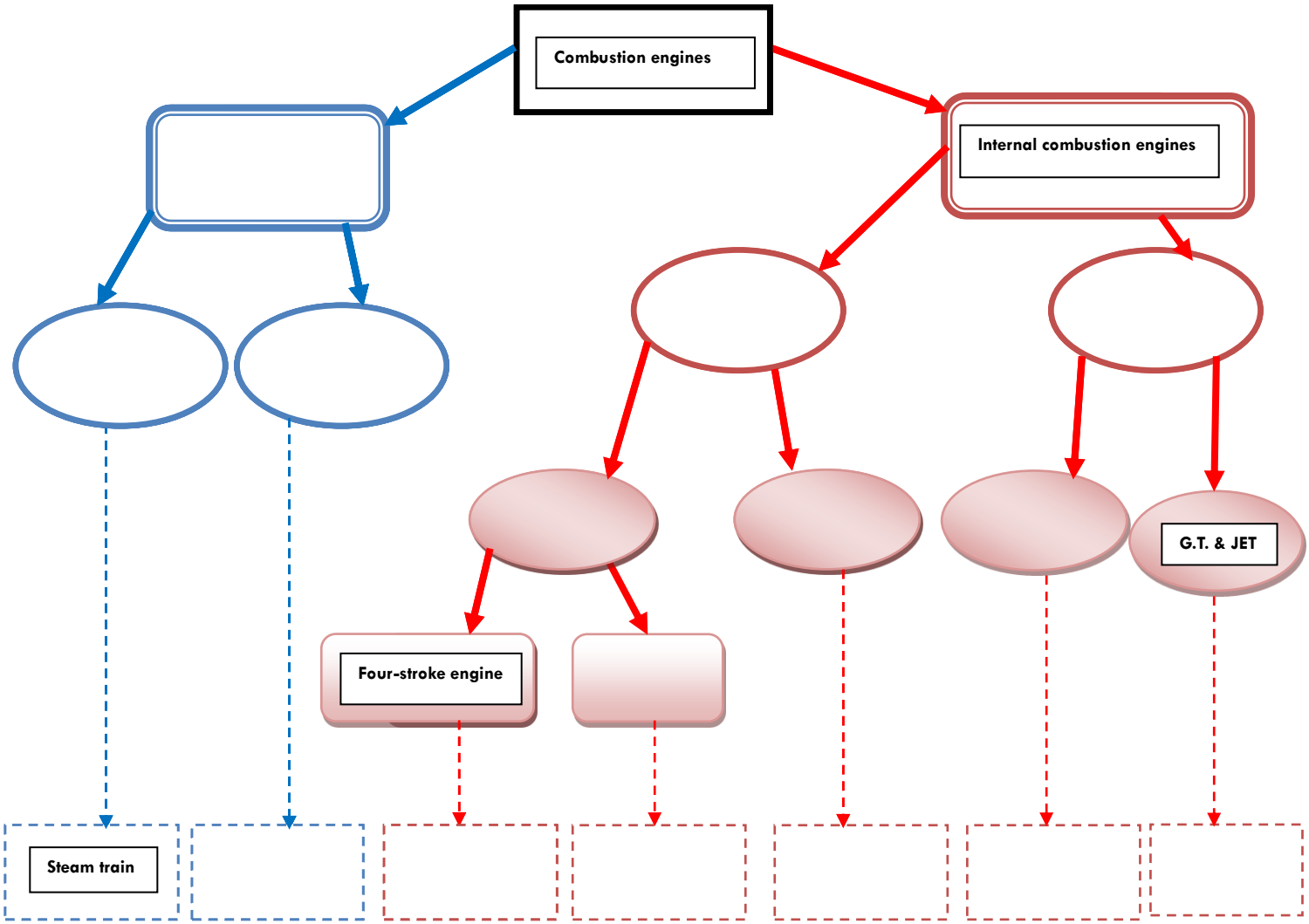
1.2. ***Compression-ignition engines***. Designed by the German engineer Rudolf Diesel in 1897. Follow the thermodynamic cycle with his name (Diesel). It is a four-stroke engine that uses the heat of compression to initiate ignition, so that is not necessary the spark plug. Use diesel (gasoil) as a combustible.

2. **Rotary engines**. Developed during the years shortly before and during the World War I. Rotary engines are internal combustion engines in which the combustion generates directly a rotary movement. It is not necessary the use of pistons. In these engines, the crankshaft remained stationary and the entire cylinder block rotated around it.

2.1. ***Wankel engine***. Invented by the German engineer Felix Wankel in the 1950s. This engine uses a rotary design to convert pressure into a rotating movement. The engine follows the thermodynamic Otto cycle, so that, it is possible to say that Wankel engine is a four-stroke engine as well. For instance, some cars such as some Mazda use this type of engine.

2.2. ***Gas turbines and jet engines***. Gas turbines are rotary engines that extract energy from a flow of combustion gas. In the combustion, the hot gases produced are forced into the turbine to move its blades and so, it is possible to generate electricity in electric power stations. Jet engines are used in different machines such as the aircrafts. Jet engines create force by releasing a high-speed jet of a liquid or a gas, pushing the plane through the air. Turbojet and turbofan engines are similar, but turbofan has a big fan in the front of the turbine that promotes its turn achieving to use less fuel, noise, and speed.

Activity 8 (***15 Points***) Fill in the gaps in the mind map using the words in the box. Remember that there are more words than gaps. **HELP**: The answers are in the text "***Combustion engines classification***". Follow the examples done.



Petrol car	External combustion engines	Compression-ignition engines	Some motorbikes		
Combustion engines	Steam engine	Wankel engine	Aircrafts	Water	Diesel cars
Smoke	Some Mazda cars	Internal combustion engines	Steam turbines	Rotary engines	
Four-stroke engine	Steam train	Piston engines	Gas turbines & jet engines (G.T & Jet)		
Spark-ignition engines	Electric train	Two-stroke engine	Electric power stations		

 **Activity 9** (***20 Points***) Answer the following questions about the texts "***Combustion engines classification***". You can use the **HELP** below:

1. (1 Point) What is an engine?
   a. A machine that converts mechanical energy (movement) into electricity.
   b. A machine that always uses steam.
   c. A machine that converts one form of energy into mechanical energy (movement).
   d. It is someone very clever.

2. (3 Points) Could a wind turbine be considered to be an engine? Why?

3. (4 Points) How can we use engines to run appliances and machines? (Ex: washing machines, cars, beaters, squeezers, etc.)

4. (1 Point) Where were fossil fuels burned in a steam engine?

5. (2 Points) How can we obtain the heat needed to run a steam engine?

6. (2 Points) Where was the steam engine used?

7. (3 Points) Write and/or describe different appliances and machines that need combustion reaction to run. (Minimum three).

8. (1 Point) Which is the general use of steam turbines?

9. (1 Point) Who is thought to have invented the two-stroke engine?

10. (2 Points) Name two rotary engines.

Some grammar help:

DEFINING				
…..	is/was a/an are/were	(generic term) place person thing concept entity device instrument tool etc	Where who which that	…..

MAKING DESCRIPTIONS
Talking about …
First of all, define what is that you are talking about and where it comes from:
This is a … It comes from …
Then describe its appearance, structure, etc:
It has … It looks like … It has a ... It is made up of … It hasn't got …
Describe the location:
It is found in …
Describe the function:
… has the job of …-ing (verb ending in ing) …
It also does …