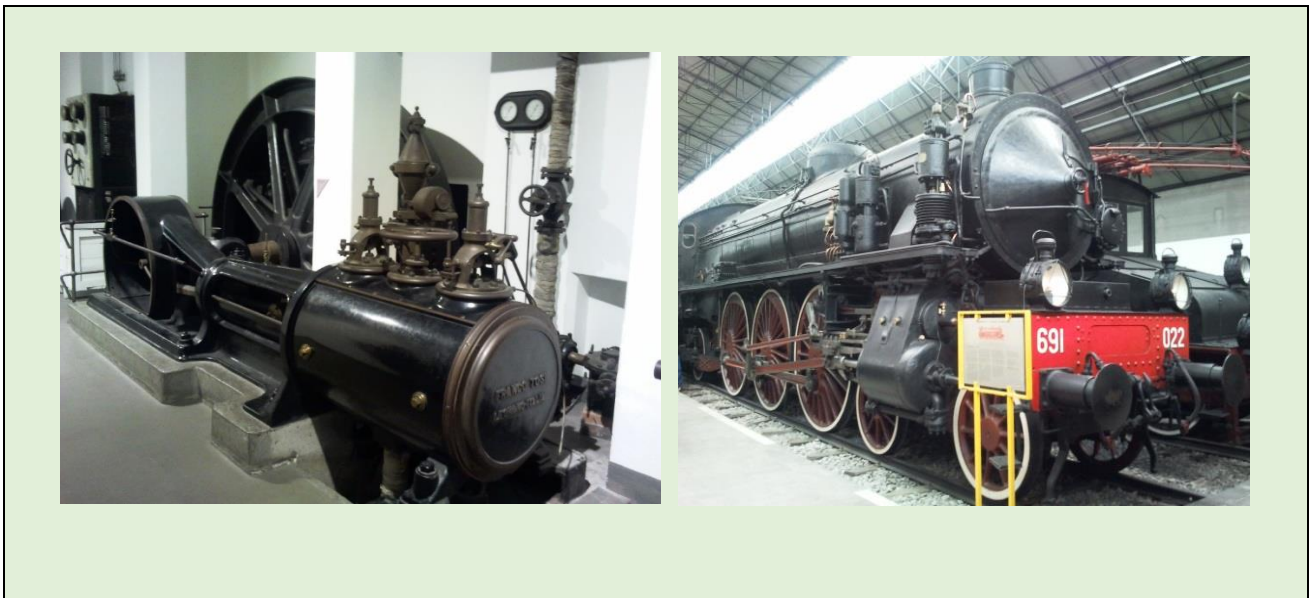


COMBUSTION ENGINES. PART 2.

EXTERNAL COMBUSTION ENGINES



STUDENT' WORKSHEET

Names:		Surnames:		Group:	Qualification
				Date:	

COMBUSTION ENGINES. PART 2. EXTERNAL COMBUSTION ENGINES

INFORMATION ABOUT ACTIVITIES:

 Individual activity

 Work in pairs

 Work in groups of three

 Work in groups of four

The first steam engine



Steam engines are machines that use the heat obtained in a chemical reaction, called *combustion*, to heat a fluid, usually water, and producing movement. In this reaction a fuel is burned, and the heat produced is used to transform the water into high pressure *steam* that moves a piston. (OPTIONAL: Watch the video: “James Watt’s Steam Engine” in <https://www.youtube.com/watch?v=SMe83R-6VE>)

Most people think that the first steam engines appear in the XVIII century, during “the Industrial Revolution” times, in the United Kingdom. The most famous steam engine is **James Watt’s steam engine** (developed between 1763 and 1775) and it was used in steam trains, steam ships, in factories, etc. But this is not true... The first steam engine didn’t appear in the XVIII century...


What was the first steam engine?

The Greek mathematician and engineer **Hero of Alexandria** worked with air pressure and steam to create rotary motion. Hero (c. 10 – 70 AD) built the ‘**Aeolipile**’ that consists of a sphere on top of a water kettle. A fire below the kettle turns the water into steam forcing the gas to pass through pipes to the sphere. Two L-shaped tubes on opposite sides of the sphere allow the gas to escape, causing a rotation movement. This engine was not used very much in the ancient world due to economic reasons (slaves did the hard work, and they were cheaper than burning wood) and because there were no practical uses for this device during the Roman Empire Times.



Hero's Aeolipile (From Wikipedia)

Optional activity: To help you to understand how a Aeolipile works, you can watch the videos: <https://www.youtube.com/watch?v=eHZgw2lgCks>, or: <https://www.youtube.com/watch?v=Y8eb3ak1f9g>

 **Activity 10 (10 Points)** Answer the following questions about the texts “**The first steam engine**”. You can use the **HELP** below:

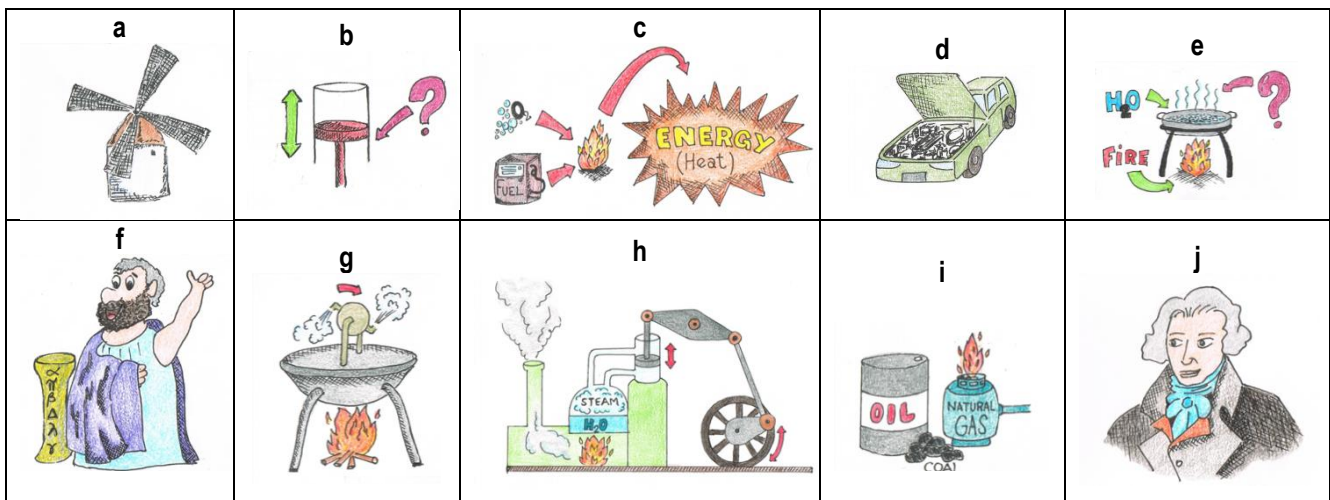
1. (1 Point) Why do you think the Aeolipile could be considered to be a steam engine?
 - a) Because the Aeolipile converts thermal energy into mechanical energy (movement).
 - b) Because it was designed by an engineer.
 - c) Because the Aeolipile converts mechanical energy (movement) into thermal energy.
 - d) The Aeolipile cannot be considered to be an engine.

2. (1 Point) What is a steam engine?
- A steam engine is a machine that uses the heat obtained in a chemical reaction, called combustion, to heat a fluid, usually water, and produces movement.
 - A steam engine is a machine that uses movement to produce heat.
 - All the engines are steam engines.
 - Steam engine was used a lot in the Ancient Greece.
3. (2 points) Describe briefly how a steam engine works.
4. (1 Point) What was the first steam engine?
- Newcomen's steam engine.
 - James Watt's steam engine.
 - Hero of Alexandria.
 - The Aeolipile.
5. (1 Point) What in the text shows you that the Aeolipile was the first steam engine?
- Hero's age.
 - The Aeolipile.
 - The dates that appear in the text.
 - The Industrial Revolution.
6. (1 Point) Who invented the most famous steam engine in the XVIII century?
- Hero of Alexandria
 - Newcomen
 - The Aeolipile
 - James Watt
7. (1 Point) What was the most used steam engine during the Industrial Revolution?
- Hero's engine.
 - The Aeolipile.
 - Watt's steam engine.
 - Newcomen's steam engine.
8. (1 Point) Where was the most famous steam engine used in the XVIII century built?
- In Greece
 - By James Watt
 - In the USA
 - In the UK
9. (1 Point) Why do you think the XVIII-XIX centuries are known as "The Industrial Revolution"?
- Because in these centuries the first steam engine was invented.
 - Because steam engines were used a lot during these centuries, starting to be used for the first time in the UK.
 - Because Hero's built his Aeolipile.
 - Because the USA built a lot of arms factories.



Activity 11 (9 Points) Match each name with the letter of a picture (See example below):

- | | |
|------------------------|---|
| 1. Combustion reaction | 2. James Watt (The Industrial Revolution) |
| 3. Engine | 4. Wind engine |
| 5. Steam | 6. Hero of Alexandria (Ancient Greece) |
| 7. Fossil fuels | 8. Aeolipile |
| 9. Piston | 10. Steam engine |



ANSWERS:

- | | | | | |
|------|----|----|----|-----|
| 1. c | 2. | 3. | 4. | 5. |
| 6. | 7. | 8. | 9. | 10. |



Activity 12 (10 Points) Imagine what our world would be like if the 'Ancient Greeks' had started to use the steam engine to build engines, cars, etc. What would our world be like nowadays? How would our history have changed? What would have happened to our environment? What would have happened to fossil fuels? Do you think it would be possible to live on other planets? What would transport be like?

Draw a picture representing the world you have imagined.



Activity 13 (20 Points) Write a composition (75-100 words). Describe the world you have imagined in the previous activity. You can use the HELP below:

SOME HELP GRAMMAR: HYPOTHESISING AND MAKING PREDICTIONS.

<p>PREDICTING</p> <p>I predict that ... will happen ... will happen If ... happens, (then) ... will happen When ... happens, (then) ... will happen Because ... happen, then ... will happen This means that ... will happen ... will not happen, unless ... happens ... will not happen, if ... does not happen</p>	<p>HYPOTHESISING</p> <p>- If ... happens, ... will happen (future, certain) (If + verb in present → will + verb). We say that if we do one thing, then it is sure that a second event will happen in the future. (We link a present action with a future outcome or result. This hypothetical sentence structure implies greater probability).</p> <p>- If ... happens, ... may/might/could happen (future, possible) (If + verb in present → modal verb (may/might/could) + verb) We say that if we do something, then it is possible that a second event will happen in the future. (In a hypothetical situation we link a present action with a possible future outcome. This hypothetical sentence structure implies less probability of the future outcome than the previous one.</p> <p>- If ... happened, ... would happen (future, possible) (If + verb in past → would + verb). We talk about possibilities, meaning that, in a hypothetical situation something would happen.</p> <p>- If ... had happened, ... would have happened (past, speculative, real events in the past) (If + verb in past perfect → would + verb in present perfect) We talk about something (a past action) we can't change. If something was done differently in the past, then maybe the outcome would have been differently, but it is just a speculation.</p> <p>Unless ... happens, ... will not happen If ... does not happen, ... will not happen Assuming ... happened, ... would happen</p>
--	--

Start the composition as follows:

In the world we have imagined, ...



OPTIONAL ACTIVITY Activity 14 Go to the web page listed below. You can take some notes.

- The first link shows different aspects about the use of steam engines. In “*locomotora*” you can watch how a steam train works. In “*Industria*”, you can watch how a steam engine works and how it was used in the textile industry. In “*Barco de vapor*”, you can build a steam ship by using some of its components.

<http://www.ub.edu/histodidactica> and go to:

“*Recursos multimedia*”, then go to:

“*Animaciones y otros recursos*”, then go to (right hand side):

“*Revolucion Industrial*” and then you can go to:

“*Locomotora*” (How does a steam train work?)

“*Industria*” (How does a textile factory work?)

“*Barco de vapor*” (How to build a steam ship)

- The second link shows (animation) how different steam engines works.

<http://animatedengines.com/> and go to: “*Steam Locomotive*”, “*Oscillating Steam*”, “*Coomber*”, “*Crank Substitute*”, “*Revolving cylinder Engine*”, “*Watt Beam*”, “*Grasshopper Beam*”, “*Unknown Beam*”, “*Newcomen Atmospheric*”, “*To cylinder Stirling*”, “*Single Cylinder Stirling*”, “*Ross Yoke Stirling*”.

- Watch the video: “*James Watt Steam engine*” to know more things about steam engines, in: <https://www.britannica.com/video/180124/James-Watt-steam-engine>



Activity 15 (14 Points) (Experts' jigsaw and running dictation activities (mixed) to present the text.

Teacher will make groups of two students with each member representing a different letter A or B. This will be your main group. After that, choose one leader in each group. This leader will write the answers in activity part 2 (Mindmap).

Part 1) Running dictation

Work in pairs, with a partner who has the same letter as you do (A or B). Your teacher will make the groups.

We are going to talk about steam engines and the most known steam engines used for the last 350 years. With your partner you have to decide who wants to write and who wants to dictate. Follow the instructions given by your teacher.

Student that has to dictate: Look around the classroom for the letter that matches your sheet (A or B). Read the information, memorise it, go back quickly to your partner, and dictate the information that is in your sheet. You are not allowed to move the sheet or to say the information aloud.

Student that has to write: Write down all the information dictated by your partner, on your sheet and on your partner's sheet.

You have 20 minutes to finish the activity.

When you finish the running dictation activity, go back to your main group partner and start doing the rest of activities.

INSTRUCTIONS FOR RUNNING DICTATION (FOR TEACHERS):

- ✓ Work in pairs.
- ✓ Assign a letter A or B to each group.
- ✓ Each group must have a runner/reader and a writer.
- ✓ First, the runner has to go around the room to find his or her sheet.
- ✓ Second, the runner has to read the sentences to himself and learn them by heart.
- ✓ Students are not allowed to touch the paper, take the paper back to the group or shout out the sentence across the room.
- ✓ Once the runner thinks he/she can remember the sentence he/she must go back to their group and tell them the memorized sentence.
- ✓ The writer of the group writes down the sentence as it is dictated. If the runner forgets part of the sentence he/she is allowed to go back to the paper and re-read and memorize it.
- ✓ The team that finishes has to revise the text and correct the mistakes.

(TEXTS)

Text adapted from Wikipedia

TEXT FOR STUDENTS A**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. This chemical reaction, called combustion, produces heat, carbon dioxide, sulphur oxides and nitrogen oxides, causing for that some environmental problems such as global warming (due to carbon dioxide) or acid rain (due to sulphur and nitrogen oxides).

Since steam takes up to over 1,000 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.

TEXT FOR STUDENTS B**The best-known steam engines**

Steam engines caused the Industrial Revolution which started in the U.K. during the XVIII – XIX centuries. Denis **Papin**'s steam digester, designed for the first time in 1679, was the first steam engine that controlled the pressure of steam limiting that by a weight.

Thomas **Savery**'s steam engine, known as "The miner's friend" as well (1698), could solve the problem of water inside mines. His engine was quite dangerous because of explosions. Savery was the first person who used the unit 'horsepower' (1 HP = 736 w), comparing his engine to the power of about 10 horses.

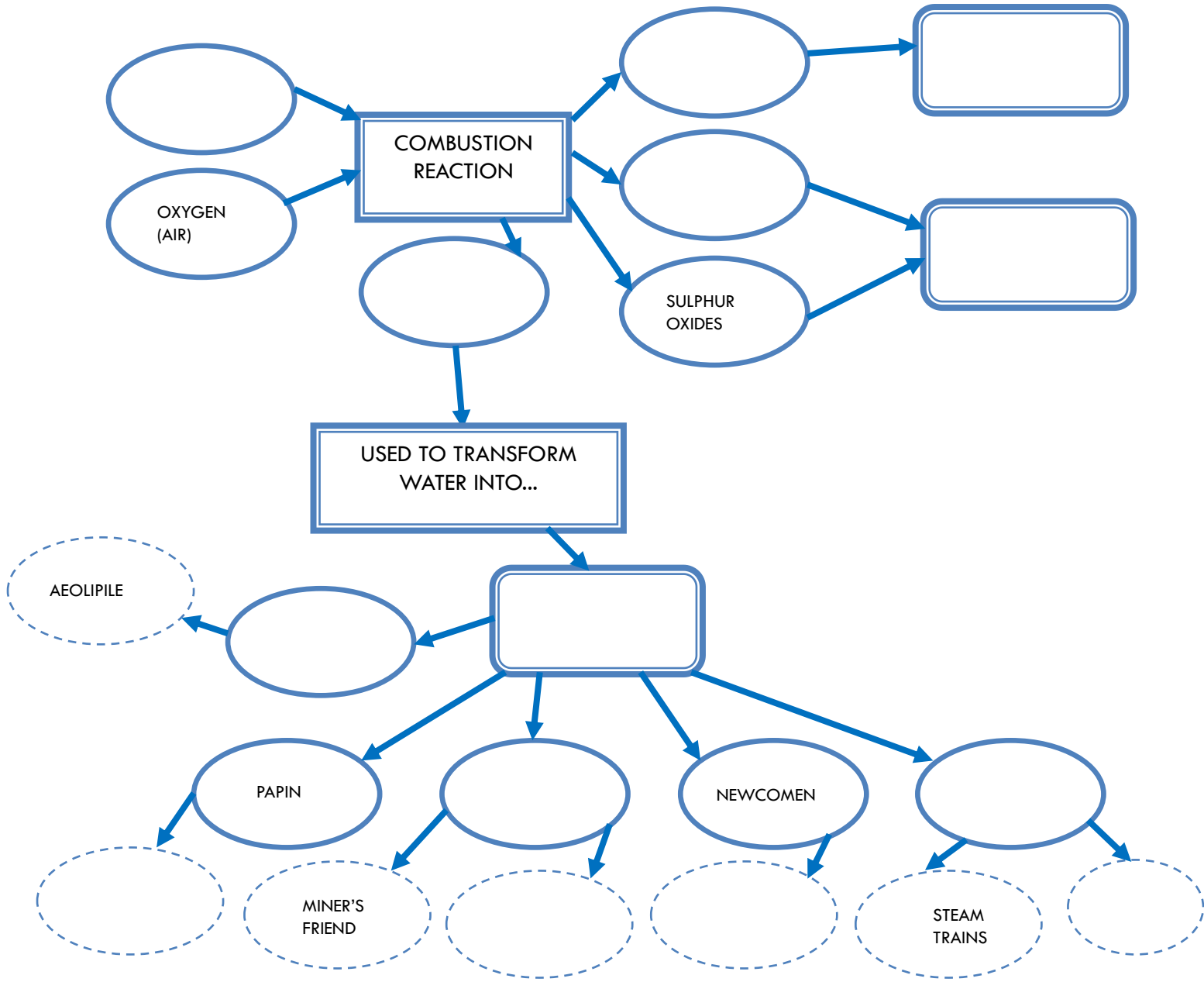
The **Newcomen**'s steam engine, built in 1712, used the force of atmospheric pressure to do the work.

James Watt designed, between 1763 and 1775, the most known steam engine used in transport and industry. The steam entrance into the cylinder was regulated by a centrifugal governor controlling the steam pressure and, this way, the speed of the steam engine.

Students have to turn back to their main group to do next activities.

Part 2) 🧑🧑 Expert Jigsaw activity. Fill in the gap's activity.

With the information that each of you have written in the running dictation activity and the previous texts, fill in the gaps in the mind map using the words in the box.

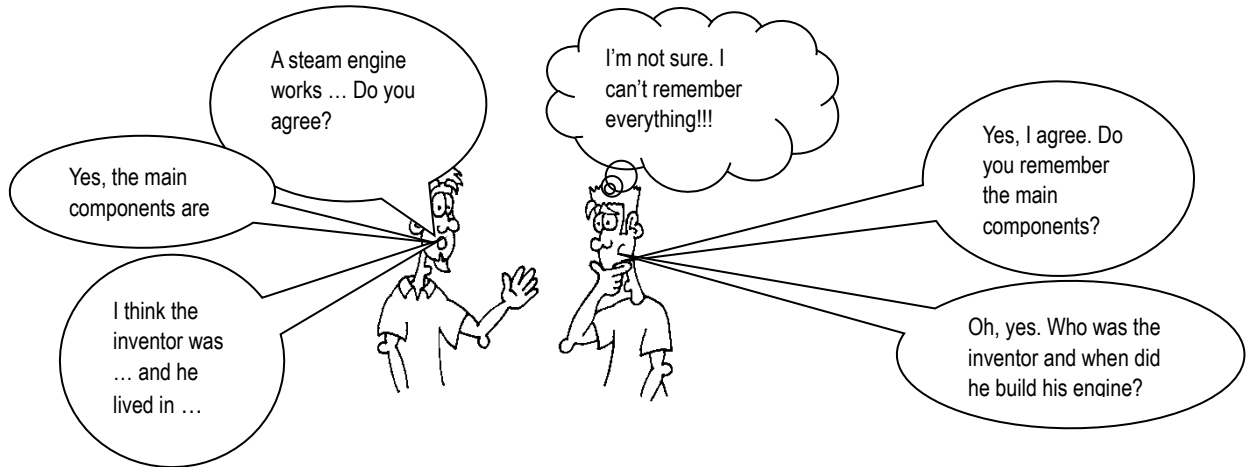


HEAT	FUEL	NITROGEN OXIDES	SAVERY	OXYGEN (AIR)	STEAM	INDUSTRY
PAPIN	MINER'S FRIEND	JAMES WATT	CARBON DIOXIDE	GLOBAL WARMING	STEAM TRAINS	
NEWCOMEN	ACID RAIN	SULPHUR OXIDES	INVENTED HORSE POWER	AEOIPILE		
STEAM PRESSURE LIMITED BY A WEIGHT	USED FORCE OF ATMOSPHERIC PRESSURE	HERO OF ALEXANDRIA				



Activity 16 (13 Points) Discuss and decide the best answer to the questions.

HELP GRAMMAR AND SPEAKING to do activity 16.



GIVING OPINIONS TO COMPARE ANSWERS
What do you think about...?
What is your opinion about ...?
Why do/does/did ...?
What are your answers in?
What have you written in ...?
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.

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		

1. (4 Points) Put the steam engines in order, from the oldest to the newest
Answer: *The first steam engine was ...*

2. (1 Point) Where was the fuel burned to boil water producing steam?
Answer: *The fuel was burned in ...*

3. (2 Points) What environmental problems does the combustion reaction produce?
Answer: *The combustion reaction can produce some environmental problems such as ...*

4. (2 Points) What was the first steam engine used to solve the water problem in the mines? Was there a problem with this steam engine?
Answers: *The first person that solved the problem of water in mines was, and the problem of his engine was*

5. (1 Point) Which steam engine was most frequently used in transport and industry?
Answer:

6. (1 Point) Who was the first person to introduce the concept of 'horsepower'?
Answer:

7. (1 Point) Which steam engine used the centrifugal governor?
Answer:

8. (1 Point) Why did the inventor use this mechanism?
Answer: *Because it was necessary to*

James Watt steam engine



By the 19 century it was necessary to transform heat into motion for transport and industry. James Watt designed the most known steam engine. Coal was burned in a furnace to heat water in the boiler. A pipe carried the **high-pressure steam** from the boiler to the **cylinder**. The steam pushed a **piston** up inside the cylinder and the **piston-rod**. The condenser made the steam turning back into water moving the piston down. A mechanism **crosshead bearing- connecting rod**, transformed the lineal movement into rotary movement. This mechanism was joined to a **crank** and an **eccentric valve motion**, producing a rotary movement in a **flywheel**. This flywheel rotated to power industrial machinery connected by a **belt**. The steam entrance into the cylinder was regulated by a **sliding valve** and a **centrifugal governor** regulated the steam pressure and so that the speed of the steam engine. The **exhaust steam** was expelled through a tube.

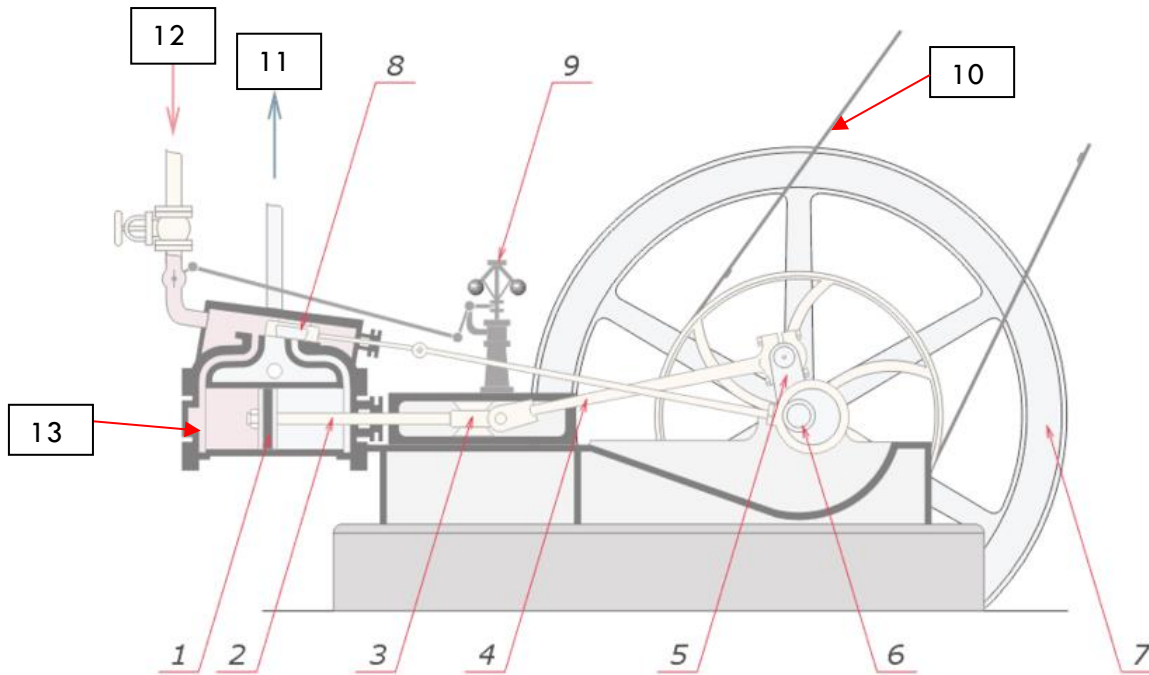
In the next video you will learn more things about the James Watt steam engine:

<https://www.youtube.com/watch?v=3xYk9cmhFHQ>

Some Help: Watch the video “Watt steam engine” in: <https://www.youtube.com/watch?v=1jVOTBZWkY4>



Activity 17 (13 Points) Match the numbers with the correct words in the James Watt steam picture. Help in the text “James Watt steam engine”. Follow the example done.



Picture from: [Steam engine nomenclature.png \(892x532\)](https://commons.wikimedia.org/wiki/File:Steam_engine_nomenclature.png) (wikimedia.org)

high-pressure steam	cylinder	piston	piston-rod	crosshead bearing
connecting rod	crank	eccentric valve motion	flywheel	
belt	sliding valve	centrifugal governor	exhaust steam	

ANSWERS:

- 1: 2: 3: 4: 5: 6: 7:
- 8: 9: 10: 11: 12: 13:



Activity 18 (5 Points) Describe, using your own words, how a James Watt's steam engine works and some of its uses.

Some grammar help:

DEFINING				
.....	is (a) are was/were	place, person thing, concept device instrument, tool, designed, build	(where) (who) (which) (that)
RELATION CAUSE-EFFECT. GIVING REASONS as a result because for example, for instance so that is why such as			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 ...	




OPTIONAL ACTIVITY: (Scale-up activity) **Activity 19 (10 Points)** Why do you think the Industrial Revolution began in the United Kingdom? (*HINT: Think about the aspects you have learned about in social sciences related to "the Industrial Revolution", about the mining (coal and iron) and textile (increase of production) industries in Britain, about the British Empire (British colonies and the different materials British had easy access to, the necessity to transport people and materials), the birth of rationalist philosophy in the XVIII century, the social classes (bourgeoisie, slavery, etc.).*)

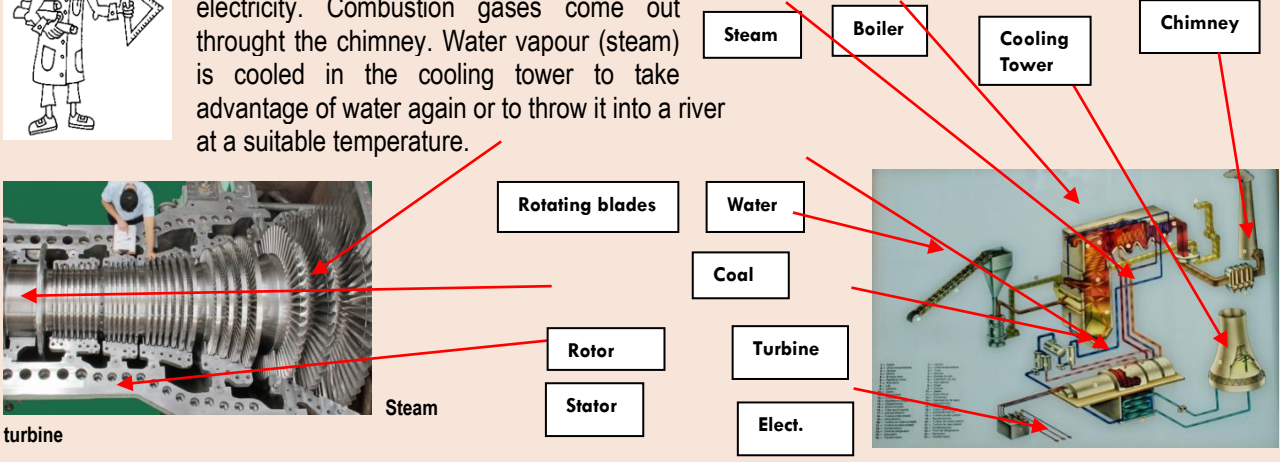
Some grammar help:

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 ...	

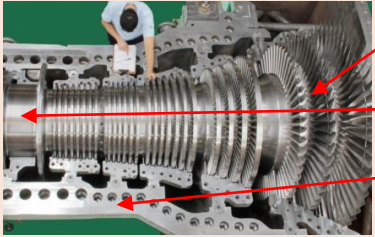
Steam turbines



A steam turbine is a rotary engine that extracts energy from steam and converts it into useful work. Normally it is used in the electric power stations to obtain electricity. The pressurized steam produced in a boiler, turns the rotor blades (the moving part) that usually is inside a fixed part called stator that has magnets. This rotary movement, because of electromagnetic reasons, is transformed into electricity. Combustion gases come out through the chimney. Water vapour (steam) is cooled in the cooling tower to take advantage of water again or to throw it into a river at a suitable temperature.



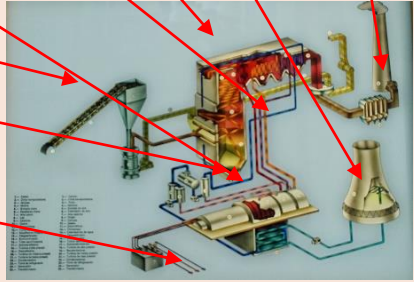
Labels in the schematic: Steam, Boiler, Cooling Tower, Chimney, Rotating blades, Water, Coal, Turbine, Rotor, Stator, Elect.



turbine

Steam

<https://www.grupotgm.com.br/es/caracteristicas-de-las-turbinas>



Coal Power Station

OPTIONAL: Watch the videos: "Electricity. Steam turbines" in: <https://studentenergy.org/conversion/steam-turbine/> and "How does a Steam Turbine Work?" in: <https://www.youtube.com/watch?v=SPq7hOxFItI>



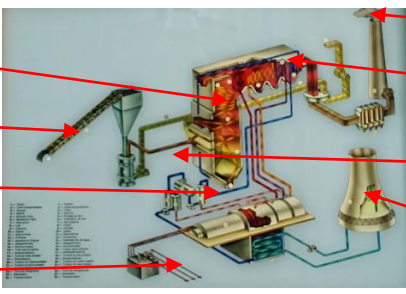
Activity 20 (12 Points) Label the picture using the words in the box below:

A

B

C

D

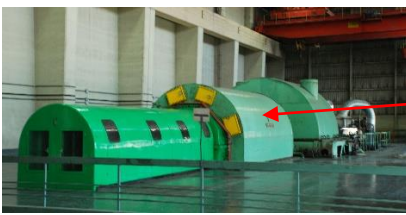


E

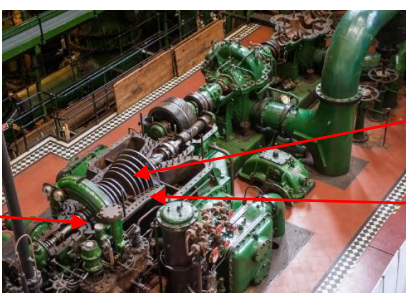
F

G

H



I



J

K

L

K

L

by Jez B <https://search.creativecommons.org/photos/5ca0129f-db39-41bb-a8dc-bf02513c3049>

COMBUSTION ENGINES. PART 2. External combustion engines.





Stator	Rotor	Rotating Blades	Coal	Turbine	Chimney
Water	Steam	Smoke	Electricity	Cooling Tower	Boiler



Self-assessment Assess yourself. Name _____

About the scenario:

1. Make a cross in the table below, according to the things you have learned in this scenario:

What to evaluate				
	Could be better 1	Satisfactory 2	Good 3	Very good 4
I learned some vocabulary related to combustion engines.				
I can identify the two types of combustion engines.				
I can describe a combustion reaction and the products obtained in it.				
I can describe briefly what is an engine.				
I'm able to search on the net real and important information related to the different combustion engines.				
I can describe briefly how an external combustion engine works.				
I can identify the main components of an external combustion engine.				
I can describe some uses of external combustion engines.				
I can relate the products obtained in a real combustion reaction with the environmental problems related to them.				
I can describe how a Power Station (using a fossil fuel) works.				
I can memorize parts of a text and dictate it to a partner.				
I can work in collaborative groups.				
I can watch a video giving conclusions about it.				
I'm able to defend my position representing a character in a role play.				
I can draw an imaginary world.				
I can write a composition explaining, describing, giving my opinion, etc. about an imaginary world.				
I'm able to give reasons, expressing my opinion.				
I can explain a work to the class (oral presentation)				
I enjoy working in groups.				
TOTAL				/76

2. Write your mark with a cross (a number between 1 and 10).

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

3. What have you learned from this scenario?
4. What was easy for you?
5. What did you find difficult?
6. What would you find most helpful?
7. What did you like doing most?
8. What did you like doing least?
9. Write the most important words (key words) learned in this scenario.
10. Any suggestions?

In the entire scenario you have...

- ❖ Used English as a way to communicate.
- ❖ Worked in pairs, respecting and analysing critically the decisions made by your partners.
- ❖ Learnt some vocabulary related to combustion engines.
- ❖ Described the most important aspects related to combustion engines.
- ❖ Identified the main components of an external combustion engine.
- ❖ Identified some uses of external combustion engines in Europe.
- ❖ Described the products obtained in a combustion reaction.
- ❖ Related the products obtained in a real combustion engine with the environmental problems due to them.
- ❖ Identified and classified external and internal combustion engines.
- ❖ Imagined and drawn an imaginary world.
- ❖ Related historical moments with the combustion engines used.
- ❖ Described how a Power Station works.
- ❖ Watched videos giving conclusions about it.
- ❖ Understood the importance of Europe in the development in the combustion engines.
- ❖ Used internet to improve your knowledge.
- ❖ Learnt how to write a definition in English.
- ❖ Learnt how to compare in English.
- ❖ Participated in a role play, defending your character.
- ❖ Learnt how to give opinions in English.
- ❖ Learnt how to prepare a good oral presentation.
- ❖ Learnt how to write a composition by hypothesising and predicting an imaginary world.
- ❖ Assessed in a critically and respectfully way the work done by your partners.
- ❖ Valued the European contribution in the development of the societies.