How an internal combustion engine works

The vast majority of vehicles (passenger cars and commercial vehicles) which are sold today are equipped with **internal combustion engines**. In this article we are going to describe how a **four stroke** internal combustion engine works.

An internal combustion engine is classified as a **heat engine**. It's called **internal** because the combustion of the air-fuel mixture occurs inside the engine, in a combustion chamber, and some of the burned gases are part of the new combustion cycle.

Basically, an internal combustion engine transforms the **thermal energy** of the burning air-fuel mixture into **mechanical energy**. It is called **4 strokes** because it takes 4 strokes for the piston to execute a complete combustion cycle. The complete name for an engine which powers a passenger car is: **4 stroke piston internal combustion engine**, abbreviated ICE (Internal Combustion Engine).

TASK 1: Drag & drop the main components of an ICE. (Arrastrar y Soltar)

intake camshaft	piston pin	spark plug	cylinder head
piston	exhaust camshaft	exhaust valve	crankshaft
intake valve	connecting rod	engine block	exhaust valve bucket

intake valve bucket

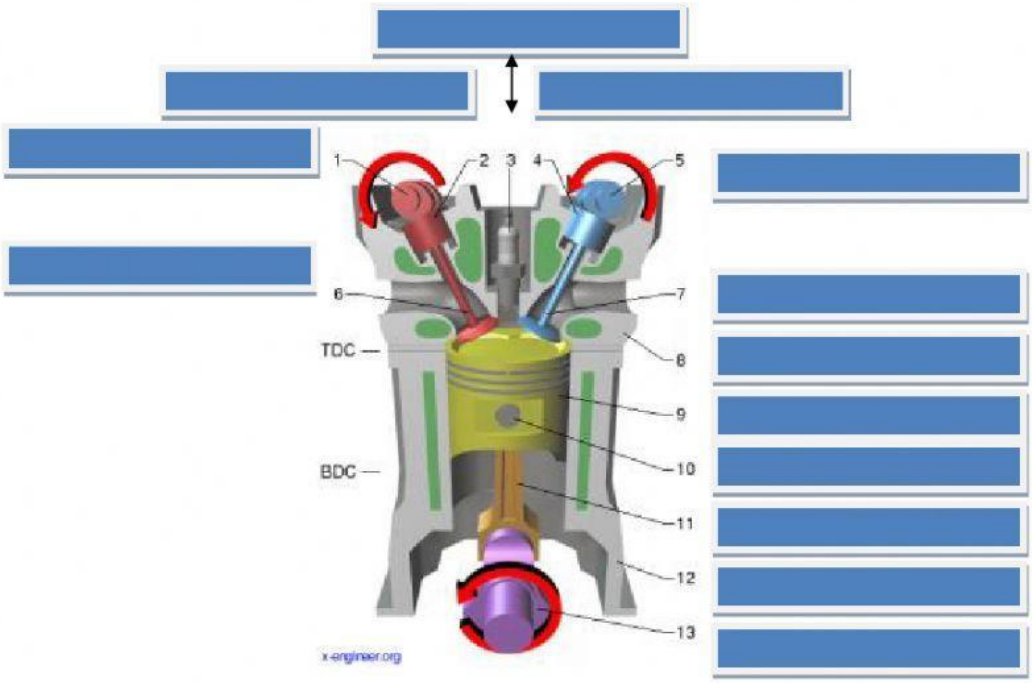


Image: Internal combustion engine (DOHC) parts

TDC – Top Dead Center

BDC – Bottom Dead Center

The **cylinder head** usually contains the camshaft(s), valves, valve buckets, valve return springs, spark/glow plugs and injectors (for direct injection engines). Through the cylinder head flows the cooling liquid of the engine.

Inside the **engine block** we can find the piston, connecting rod and crankshaft. As for the cylinder head, through the engine block flows coolant to help control the temperature of the engine.

The piston moves inside the cylinder from BDC to TDC. The **combustion chamber** is the volume created between piston, cylinder head and engine block when the piston is close to TDC.

In Figure 1 we can examine the complete set of mechanical components of an ICE. Some of the components are fixed (e.g. cylinder head, cylinder block) and some of them are moving. In the figure below we'll have a look at the main moving part of an ICE, which transform the gas pressure within the cylinder in mechanical power.

TASK 2: Drag & drop the Internal Combustion Engine moving parts

connecting rod | crankshaft | valve bucket

valve | camshaft | piston

camshaft sprocket

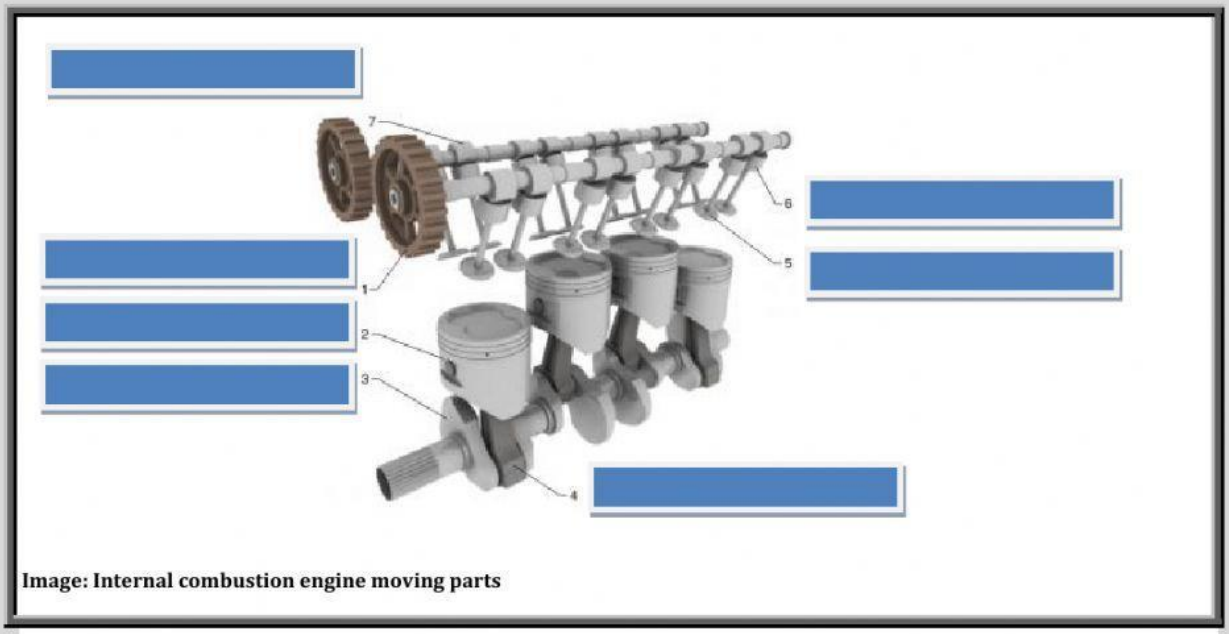


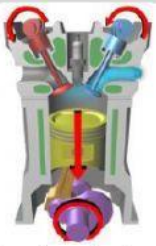
Image: Internal combustion engine moving parts

The rotation of the camshaft is **synchronised** with the rotation of the crankshaft through a toothed belt or chain. The position of the intake and exhaust valves must be precisely synchronised with the position of the piston, to allow the combustion cycles to take place accordingly.

A complete engine cycle for a 4 stroke ICE has the following phases (strokes): **1. Intake – 2. Compression – 3. power (expansion) – 4. Exhaust.**

A stroke is the movement of the piston between the two dead centres (bottom and top).
Now, that we know which are the components of an ICE, we can examine what is happening in each stroke of the engine cycle. In the table below you'll see the position of the piston at the beginning of each stroke and the details regarding the events that take place in the cylinder.

Stroke 1 – INTAKE



Internal combustion engine intake stroke

At the beginning of the intake stroke the piston is close to TDC. The intake valve is opened, the piston starts to move towards the BDC. Air (or air-fuel mixture) is drawn into the cylinder. This stroke is called INTAKE because fresh air/mixture is taken into the engine. The intake stroke ends when the piston is at the BDC.
During the intake stroke, the engine consumes energy (the crankshaft is rotating due to the inertia of the components).

Stroke 2 – COMPRESSION

Internal combustion engine

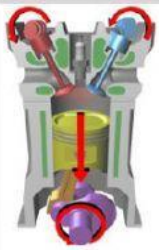
The compression stroke starts with the piston at BDC, after the intake stroke is finished. During the compression stroke both valves, intake and exhaust, are closed, and the pistons moves towards TDC. With both valves closed, the air/mixture is compressed, reaching maximum pressure when the piston is close to TDC.
Before the piston reaches the TDC (but very close to it), during the compression stroke:

- for gasoline engine: the spark is generated
- for diesel engines: fuel is injected

During the compression stroke, the engine consumes energy

compression stroke (the crankshaft is rotating due to the inertia of the components), more than the intake stroke.

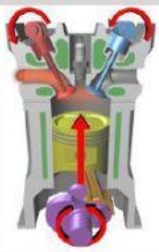
Stroke 3 – POWER



Internal combustion engine power stroke

The power stroke starts with the piston at TDC. Both valves, intake and exhaust, are still closed. The air-fuel mixture combustion started at the end of the compression stroke, which causes a significant increase of pressure inside the cylinder. The pressure inside the cylinder pushes the piston down, towards the BDC.
Only during the power stroke the engine produces energy.

Stroke 4 – EXHAUST



Internal combustion engine exhaust stroke

The exhaust stroke starts with the piston at the BDC, after the power stroke finished. During this stroke, the exhaust valve is open. The movement of the piston from the BDC towards the TDC pushes most of the exhaust gases out of the cylinder, into the exhaust pipes.
During the exhaust stroke, the engine consumes energy (the crankshaft is rotating due to the inertia of the components).

As you can see, in order to have a **complete combustion** (engine) cycle the piston has to perform 4 strokes. This means that one engine cycles takes **two complete rotations of the crankshaft** (720°).
The only stroke which produces torque (energy) is the **power stroke**, all the others are consuming energy.

The **linear motion of the piston** is transformed into **rotational motion of the crankshaft** through the connecting rod.

TASK 3: Complete the table below with the corresponding information about the piston initial position, valve position and energy balance for each stroke.

Stroke order	Stroke name	Piston initial position	Intake valve state	Exhaust valve state	Energy balance
1		TDC	Open		Consumes
2				Closed	
3					
4			Closed		

***Click on the link below* to see the internal combustion engine animation.**

In the animation below you can see clearly how the internal combustion engine works. Pay attention to piston position, valve position, the moment when the ignition occurs and the succession of the strokes.

https://x-engineer.org/wp-content/uploads/internal_combustion_engine_animation.gif?f7a483&f7a483