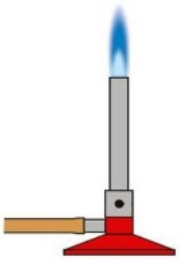
COMBUSTION

Complete combustion

Complete combustion occurs when there is a plentiful supply of oxygen and produces carbon dioxide and water.
In a Bunsen burner, complete combustion is characterised by a blue, non-luminous flame.
An example word equation for complete combustion is: Carbon compound + oxygen → carbon dioxide + water
e.g. Methane + oxygen → carbon dioxide + water

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

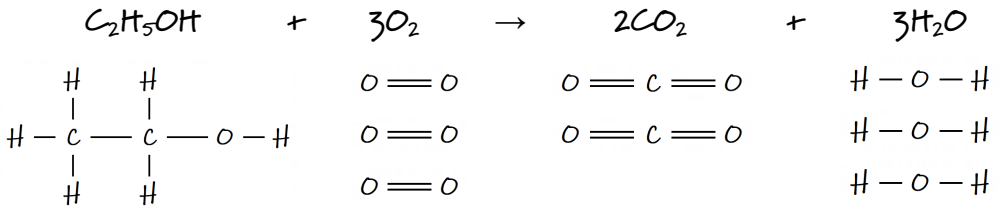


Ethanol is used as a fuel in some camping stoves, burning with an almost invisible flame.
Ethanol + oxygen → carbon dioxide + water

The unbalanced chemical equation is:

$$C_2H_5OH + O_2 \rightarrow CO_2 + H_2O$$

The 2 carbons in ethanol will form $2CO_2$
The 6 hydrogens in ethanol will form $3H_2O$
The unbalanced chemical equation is: $C_2H_5OH + O_2 \rightarrow 2CO_2 + 3H_2O$
There are now 7 oxygens in total on the product's side AND 1 oxygen on the reactants side from the C_2H_5OH. This means that an additional $3O_2$ are required on the reactant side to balance the equation.
The balanced chemical equation is:

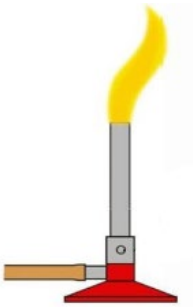


Incomplete combustion

In comparison, incomplete combustion:

- Occurs when there is a limited supply of oxygen.
- Always forms water as a product (from the hydrogen present in the carbon compound).
- Produces carbon dioxide and/or carbon monoxide and/or carbon (in varying proportions).

In a Bunsen burner, incomplete combustion of methane produces a yellow flame.



Incomplete combustion tends to place inside a car engine and inside faulty gas appliances due to a limited amount of oxygen present.

An example word equation for incomplete combustion to form carbon monoxide is:

Carbon compound + (limited) oxygen → carbon monoxide + water

e.g. Propane + oxygen → carbon monoxide + water

$C_3H_8\,(g) + 3\frac{1}{2}O_2\,(g) \rightarrow 3CO\,(g) + 4H_2O\,(l)$

As carbon monoxide is colourless and odourless it will be unnoticed which makes it extremely dangerous. Carbon monoxide binds irreversibly to haemoglobin in the blood, limiting the capacity of haemoglobin in red blood cells to bind and transport oxygen. This can be fatal to individuals.

With a very reduced supply of oxygen, carbon will be produced in the form of soot.

Carbon compound + (limited) oxygen → carbon + water

e.g. Propane + oxygen → carbon + water

$C_3H_8\,(l) + 2O_2\,(g) \rightarrow 3C\,(g) + 4H_2O\,(l)$

A sooty, yellow flame occurs when incomplete combustion is taking place. Compounds with a higher carbon content tend to undergo incomplete combustion and produce more soot.

NOTE: There is no way for you to know how much CO_2 or CO or C is formed, as there is no unique equation for incomplete combustion.

Another possible equation for incomplete combustion might be: $C_3H_8 + 3O_2 \rightarrow 2CO + C + 4H_2O$.