



Complete and Incomplete Combustion

Unit 6 Lesson 3

Complete and Incomplete Combustion

Students will be able to:

- Define combustion
- Write a chemical reaction for the combustion of a fuel.
- Compare and contrast complete and incomplete combustion

Key Vocabulary:

Complete combustion, Exothermic reaction, Fuel, Hemoglobin, Incomplete combustion, Soot

Complete and Incomplete Combustion

What is a Combustion Reaction?

- Combustion is the chemical reaction between a fuel and oxygen in the air.
- This is an exothermic reaction as it releases a lot of energy.
- Burning wood, petrol, coal, and ethanol are all examples of combustion reactions.



Complete and Incomplete Combustion

What is a Combustion Reaction?

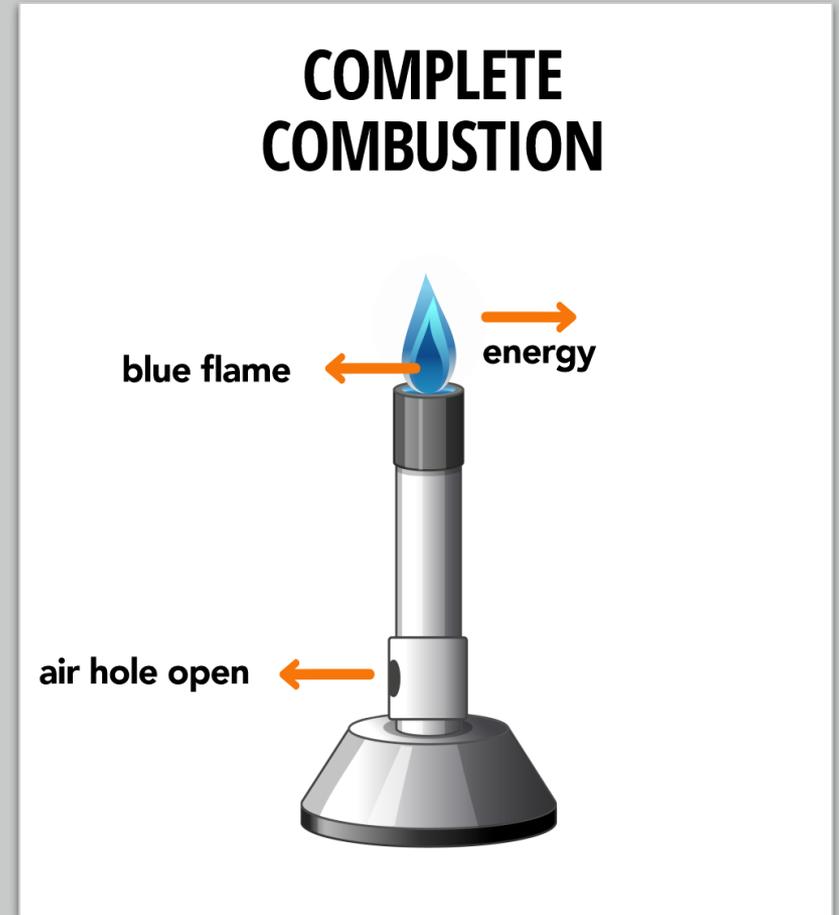
- Many fuels are made up hydrocarbons (compounds consisting only of carbon and hydrogen atoms), which means that whenever they burn, the products of the reaction are always the same.
- There are two types of combustion reaction. These depend on the amount of oxygen available to the fuel during the reaction.



Complete and Incomplete Combustion

1. Complete Combustion

- When fuels burn in a plentiful supply of oxygen, they release a lot of energy. This reaction produces carbon dioxide and water vapor.
- Complete combustion occurs each time a blue flame is used to heat a substance with a Bunsen Burner.
- Opening the air hole on the Bunsen allows for maximum oxygen supply.



Complete and Incomplete Combustion

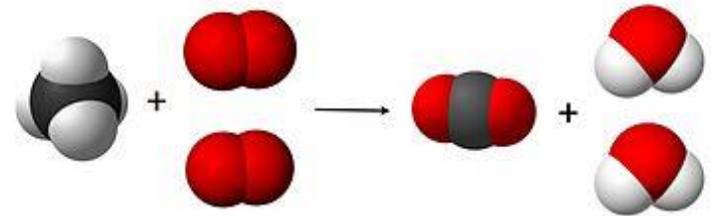
1. Complete Combustion

Complete combustion reaction can be summarized using the following word equation:

Fuel + Oxygen → Carbon dioxide + Water

Example:

Methane and oxygen react in a plentiful supply of oxygen, the reaction will be:



Methane + Oxygen → Carbon dioxide + Water

Complete and Incomplete Combustion

Activity 1:

For each of the following complete combustion reactions, add in the missing reactants and products. Then write the balanced chemical equation for each reaction.

- a) The complete combustion of ethane
- b) The complete combustion of propane

Complete and Incomplete Combustion

Activity 1: Answers

For each of the following complete combustion reactions, add in the missing reactants and products. Then write the balanced chemical equation for each reaction.

a) The complete combustion of ethane

Word Equation: Ethane + **Oxygen** → Carbon dioxide + **Water**

Chemical Equation: $2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$

Complete and Incomplete Combustion

Activity 1: Answers

For each of the following complete combustion reactions, add in the missing reactants and products. Then write the balanced chemical equation for each reaction.

b) The complete combustion of propane

Word Equation: Propane + Oxygen \rightarrow **Carbon dioxide** + **Water**

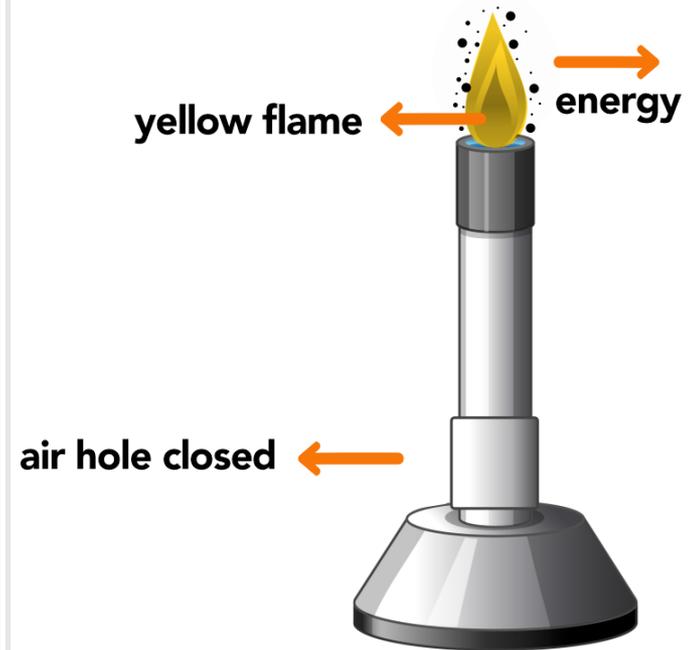
Chemical Equation: $\text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}$

Complete and Incomplete Combustion

2. Incomplete Combustion

- When a fuel burns in a limited supply of oxygen incomplete combustion occurs.
- This reaction results in different products to complete combustion due to the lack of oxygen available.
- We see incomplete combustion occurring when the airhole on the Bunsen burner is left closed.

INCOMPLETE COMBUSTION

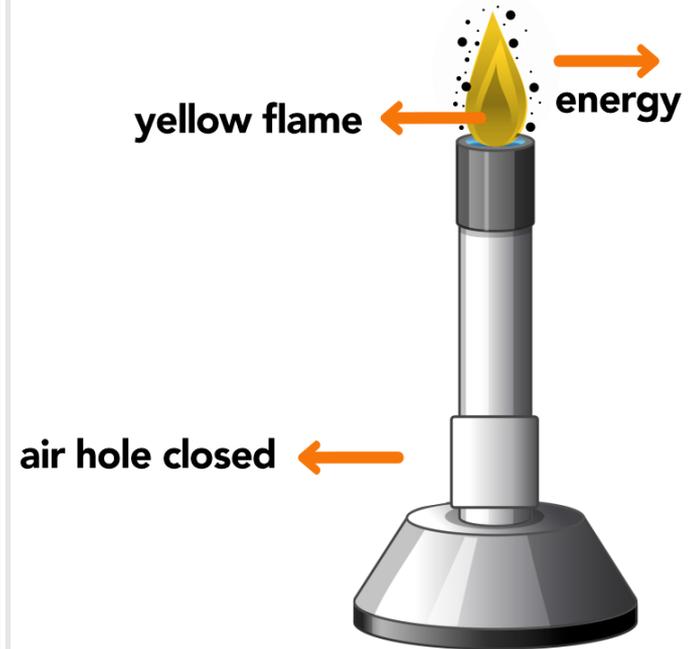


Complete and Incomplete Combustion

2. Incomplete Combustion

- The oxygen atoms will first combine with the hydrogen atoms from the fuel, producing water, which is why it is a product in both complete and incomplete combustion reactions.
- Some of the carbon atoms will not be able to react with oxygen and will be released as gaseous carbon or soot which collects on glassware e.g., beakers and test tubes as they cool.

INCOMPLETE COMBUSTION

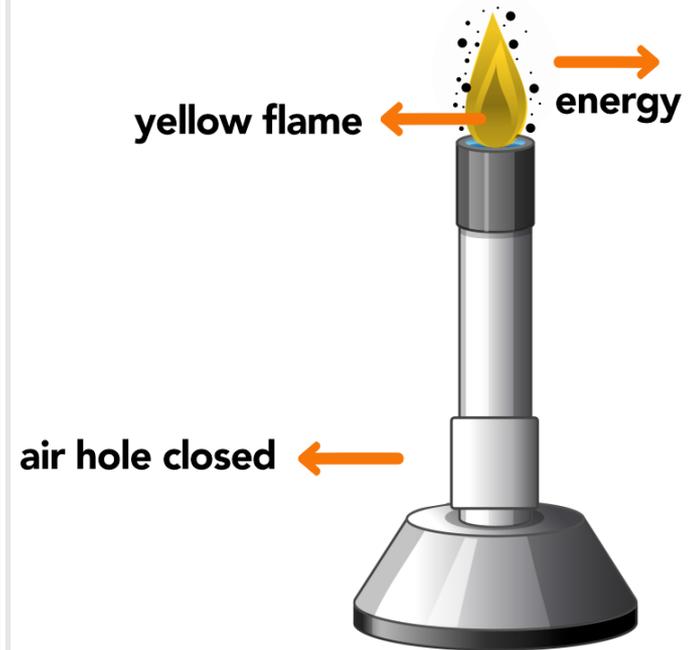


Complete and Incomplete Combustion

2. Incomplete Combustion

- In some cases, small particles of soot flicker around the flame.
- Hot carbon atoms glow with a yellow light which gives the safety flame its yellow color.
- If there is enough oxygen, the poisonous gas carbon monoxide is formed, either as well as, or instead of carbon.

INCOMPLETE COMBUSTION



Complete and Incomplete Combustion

2. Incomplete Combustion

Incomplete combustion reaction can be summarized using the following word equation:

Fuel + Oxygen → Carbon monoxide + Carbon + Water

Example:

When methane is burnt in limited oxygen the equation will be:



Methane + (limited) Oxygen → Carbon Monoxide + Carbon +

Water

The balanced chemical equation for this reaction will therefore be:



Complete and Incomplete Combustion

Activity 2:

For each of the following incomplete combustion reactions, add in the missing reactants and products. Then write the balanced chemical equation for each reaction.

- a) Water and carbon monoxide are produced when pentane reacts with limited oxygen:

- b) Octane is ignited when a match is burnt, producing soot.

Complete and Incomplete Combustion

Activity 2: Answers

For each of the following incomplete combustion reactions, add in the missing reactants and products. Then write the balanced chemical equation for each reaction.

- a) Water and carbon monoxide are produced when pentane reacts with limited oxygen:

Word Equation: **Pentane + (limited) Oxygen → Carbon monoxide + Water**

Chemical Equation: **$2\text{C}_5\text{H}_{12} + 11\text{O}_2 \rightarrow 10\text{CO} + 12\text{H}_2\text{O}$**

Complete and Incomplete Combustion

Activity 2: Answers

For each of the following incomplete combustion reactions, add in the missing reactants and products. Then write the balanced chemical equation for each reaction.

b) Octane is ignited when a match is burnt, producing soot.

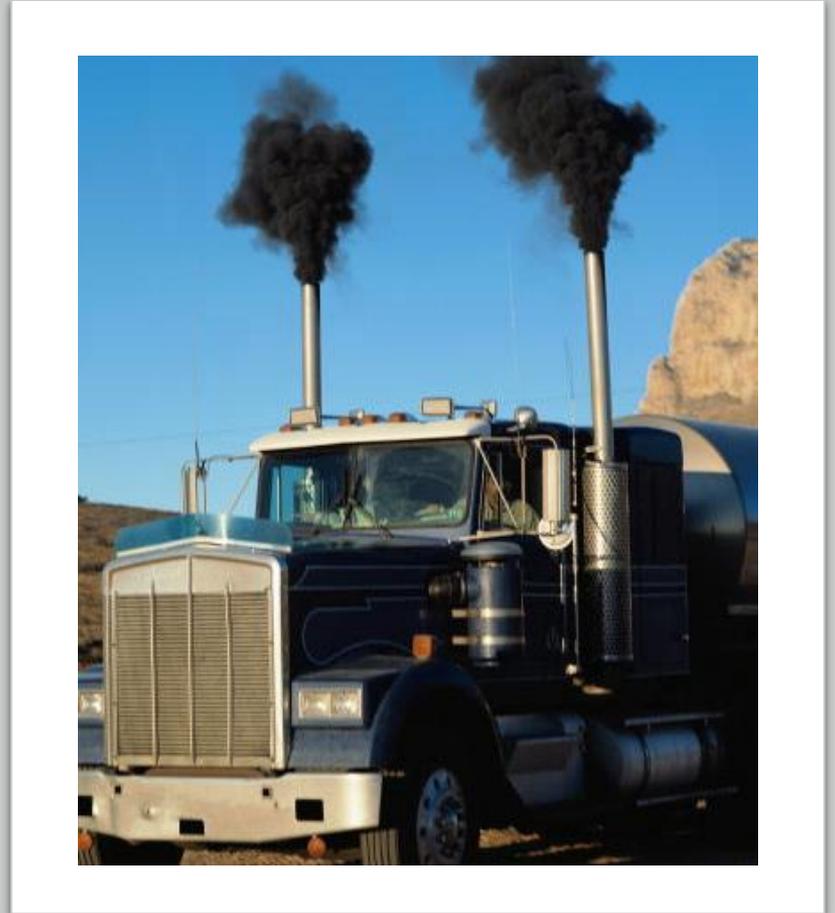
Word Equation: **Octane + (limited) Oxygen → Carbon + Water**

Chemical Equation: **$2\text{C}_8\text{H}_{18} + 9\text{O}_2 \rightarrow 16\text{C} + 18\text{H}_2\text{O}$**

Complete and Incomplete Combustion

The Dangers of the Products of Incomplete Combustion:

- These products are extremely dangerous to humans and animals.
- Carbon particles (soot) can affect the lungs, if they are inhaled and may trigger medical issues such as asthma.
- Repeated exposure can lead to the formation of lung cancer. There is also evidence that suggests that soot can enter the arteries, leading to heart disease.



Complete and Incomplete Combustion

The Dangers of the Products of Incomplete Combustion:

- Carbon monoxide has more rapid effects and is deadly, due to it being colorless and odorless.
- It can quickly enter the bloodstream and bind to hemoglobin in the place of oxygen which starves the body of oxygen leading to rapid cell and tissue death and death of the individual.

