

# Combustion of Hydrocarbons

**Answer the questions below.**

1. Name the process used to separate crude oil.

**Fractional distillation**

2. Explain how this process separates crude oil.

**Hydrocarbons evaporate and condense at different temperatures depending on their boiling point.**

3. Describe the pattern of viscosity as hydrocarbon chains get longer.

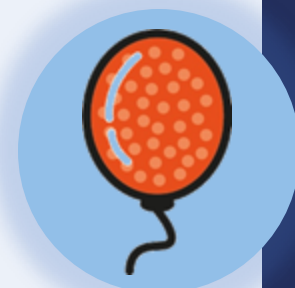
**As hydrocarbon chains get longer, viscosity increases.**

4. Name the alkane that contains two carbon atoms.

**Ethane**

5. Explain the difference between an exothermic and an endothermic reaction.

**An exothermic reaction transfers energy to the surroundings whereas an endothermic reaction takes in energy from the surroundings.**



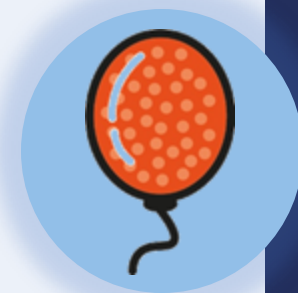
# Combustion of Hydrocarbons

## **Do Now:**

1. Name the process used to separate crude oil.
2. Explain how this process separates crude oil.
3. Describe the pattern of viscosity as hydrocarbon chains get longer.
4. Name the alkane that contains two carbon atoms.
5. Explain the difference between an exothermic and an endothermic reaction.

## **Drill:**

1. Name the compound with the formula  $\text{CH}_4$ .
2. Calculate the relative formula mass of propane.  $\text{C}=12$ ,  $\text{H}=1$
3. Calculate the percentage by mass of carbon in ethane.

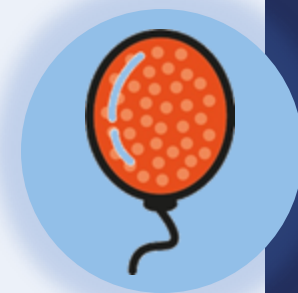


# Combustion of Hydrocarbons

## Read Now:

Many of the hydrocarbons in crude oil are used as fuels. A fuel is any substance that is burned to release energy. Combustion is the chemical reaction that takes place when a substance burns in air, so when hydrocarbons are burned, these are combustion reactions. These reactions are useful as they are highly exothermic, which means they transfer a large amount of energy to the surroundings. The main advantage of burning hydrocarbons is this release of energy, although there are also disadvantages. Combustion of hydrocarbons produces carbon dioxide as a product, which contributes to global warming. Scientists and companies are developing new fuels that are less harmful to the environment, but humans are still dependent on crude oil as a fuel source for heating homes, gas for cooking and fuel for cars and other modes of transport.

1. Explain what is meant by a fuel.
2. Explain what is meant by a combustion reaction.
3. Explain why combustion of hydrocarbons is a useful chemical reaction.
4. Give a disadvantage of burning hydrocarbons.
5. Describe two uses of hydrocarbons for humans.



# Combustion of Hydrocarbons

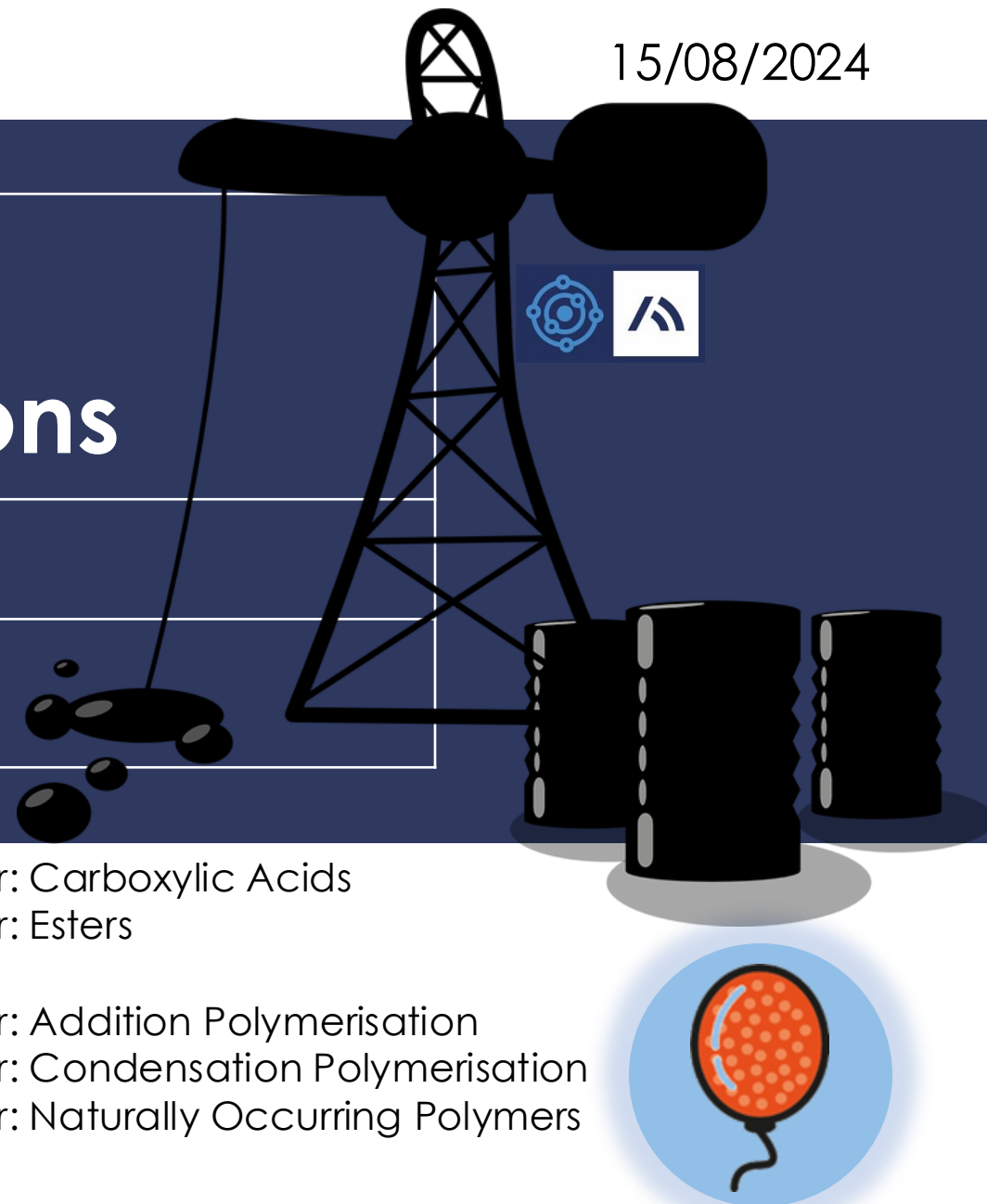
## C5.1.4

Science  
**Mastery**

- C5.1.1 Prior Knowledge Review
- C5.1.2 Crude Oil and Hydrocarbons
- C5.1.3 Fractional Distillation
- **C5.1.4 Combustion of Hydrocarbons**

- C5.1.5 Cracking
- C5.1.6 Taking it Further: Alkenes
- C5.1.7 Taking it Further: Alcohols
- C5.1.8 Taking it Further: Producing Ethanol by Fermentation
- C5.1.9 Taking it Further: Producing Ethanol from Ethene

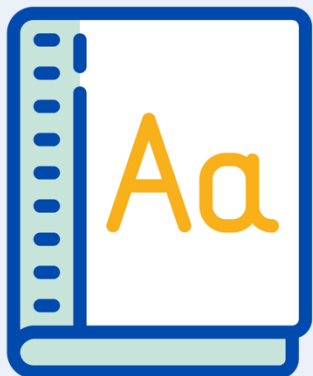
- C5.1.10 Taking it Further: Carboxylic Acids
- C5.1.11 Taking it Further: Esters
- C5.1.12 Polymers
- C5.1.13 Taking it Further: Addition Polymerisation
- C5.1.14 Taking it Further: Condensation Polymerisation
- C5.1.15 Taking it Further: Naturally Occurring Polymers



## Following this lesson, students will be able to:

- State the general equation for the combustion of alkanes
- Describe the advantages and disadvantages of the combustion of hydrocarbons
- Explain the difference between complete and incomplete combustion

## Key Words:



**alkane**

**combustion**

**incomplete**

**exothermic**

**oxidation**

# This is the fix-it portion of the lesson

The **fix-it** is an opportunity to respond to gaps in knowledge, especially those identified by the **pre-unit quiz**.

- The teacher should customise this slide as needed, to facilitate
  - **reteach, explanation, demonstration** or **modelling** of ideas and concepts that students have not yet grasped or have misunderstood.
  - **practise** answering specific questions or of key skills.
  - **redrafting** or **improving** previous work.

## Answer the questions below.

1. How does fractional distillation separate crude oil into fractions?
  - ☐ A. Each fraction has a different viscosity
  - ☐ B. Each fraction has a different melting point
  - ☒ C. Each fraction has a different boiling point
2. Which fraction is used for producing material for roads?
  - ☐ A. Liquefied gases
  - ☐ B. Petrol
  - ☒ C. Bitumen
3. Which best explains the pattern in boiling points of the alkanes?
  - ☐ A. As the alkanes get longer, boiling points increase because there are more atoms
  - ☐ B. As the alkanes get longer, boiling points decrease because they are more likely to be liquid
  - ☒ C. As the alkanes get longer, boiling points increase because the intermolecular forces increase

# Combustion of Hydrocarbons

Many of the hydrocarbons found in crude oil can undergo **combustion**.

Combustion of hydrocarbons releases a lot of **energy**, which is why they are useful as **fuels**.

The general equation for the combustion of alkanes is:



Carbon and hydrogen from the alkane are both **oxidised** as they **gain oxygen**.

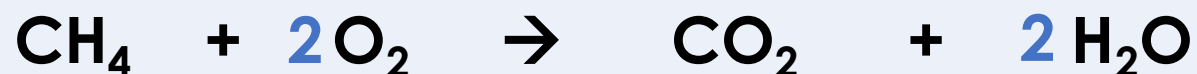


# Complete Combustion

When there is a good supply of air (and therefore oxygen), complete combustion takes place.

**Alkane + oxygen → carbon dioxide + water**

**Methane + oxygen → carbon dioxide + water**



This reaction is highly **exothermic** as it transfers a lot of **energy** to the surroundings.





# Incomplete Combustion

When there is a limited supply of air (and therefore oxygen), **incomplete combustion** takes place.

This still produces water but produces **carbon** and **carbon monoxide** rather than carbon dioxide.

This reaction is also **exothermic** but releases less energy than complete combustion.

**Carbon monoxide** is very dangerous as it is **toxic**.

Another problem with burning hydrocarbons is that some may contain **sulfur impurities**, which burn to produce **sulfur dioxide** and leads to **acid rain**.



**Which statements do you agree with?**

Combustion of alkanes releases energy to the surroundings

Combustion of alkanes takes in energy from the surroundings

During combustion, alkanes react with air

During combustion, alkanes react with oxygen

# How many links can make between this lesson and the science you've learned before?



*What type of reaction is combustion?*

*What would the reaction profile for combustion look like?*

*What type of bonding is found in hydrocarbons?*

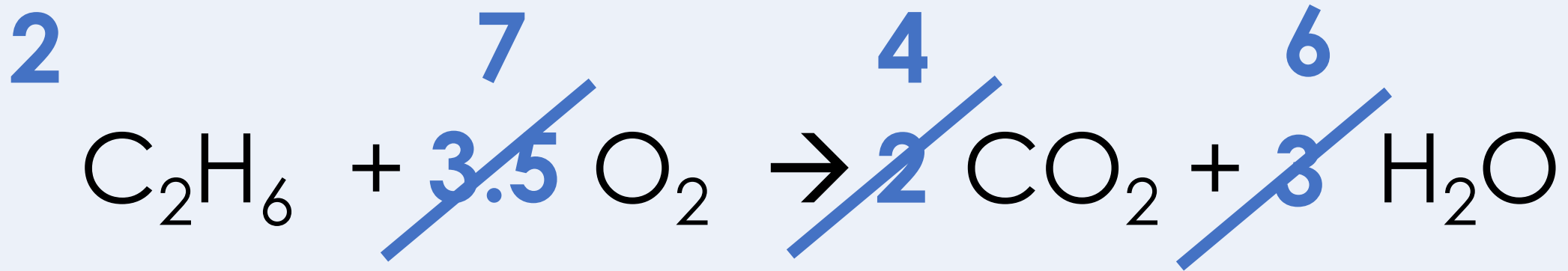
*What are the products of combustion of alkane?*

*What does this have to do with global warming?*

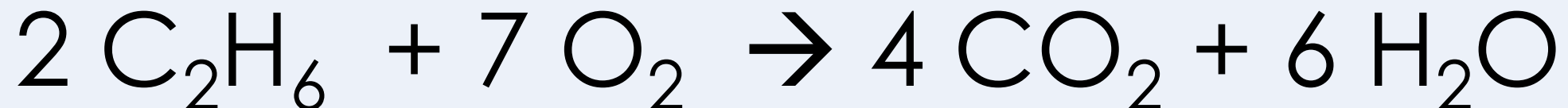
*What are the biological consequences of global warming?*

## Balancing Equations Challenge

The chemical equation for the combustion of **ethane** is:



*Can you balance this equation?*



## Determine if each of these statements are true or false

1. The alkane with one carbon is called methane **True**
2. Combustion of propane produces water and oxygen **False**
3. The products of combustion are different depending on which alkane reacted **False**
4. Incomplete combustion occurs when there is insufficient oxygen **True**
5. Carbon dioxide produced from combustion is the main cause of acid rain **False**

# Drill

1. Name the substance that hydrocarbons react with during combustion.
2. State the two products of combustion of hydrocarbons.
3. Identify which product is linked to global warming.
4. Explain the difference between complete and incomplete combustion.
5. Describe how sulfur dioxide is formed.
6. State the environmental problem associated with sulfur dioxide.
7. Explain which fractions of crude oil can be burned most easily.

## Drill answers

1. Oxygen
2. Water and carbon dioxide
3. Carbon dioxide
4. Complete combustion happens when there is plenty of oxygen available whereas incomplete combustion occurs when there is not enough oxygen. Incomplete combustion produces carbon and carbon monoxide (and water) rather than carbon dioxide (and water).
5. Hydrocarbon fractions many contain sulfur impurities, which react with oxygen during combustion to form sulfur dioxide.
6. Acid rain
7. The fractions with the shortest hydrocarbon chains as they are most flammable.

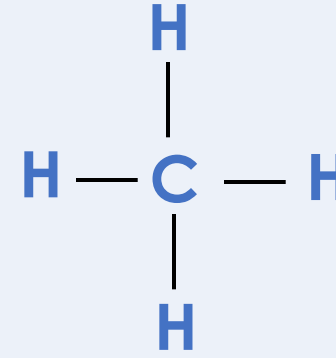
# I: Combustion Reactions

Methane burns in air.

*What is the chemical formula for methane?*



*Draw the structural formula for methane.*



*Write a word equation for the combustion of methane.*

**Methane + oxygen  $\rightarrow$  carbon dioxide + water**

*Write a symbol equation for the combustion of methane.*



*Balance the symbol equation.*





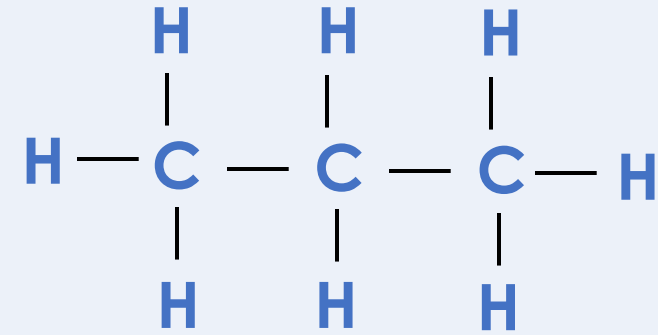
# We: Combustion Reactions

Propane burns in air.

*What is the chemical formula for propane?*



*Draw the structural formula for propane.*



*Write a word equation for the combustion of propane.*

**Propane + oxygen → carbon dioxide + water**

*Write a symbol equation for the combustion of propane.*



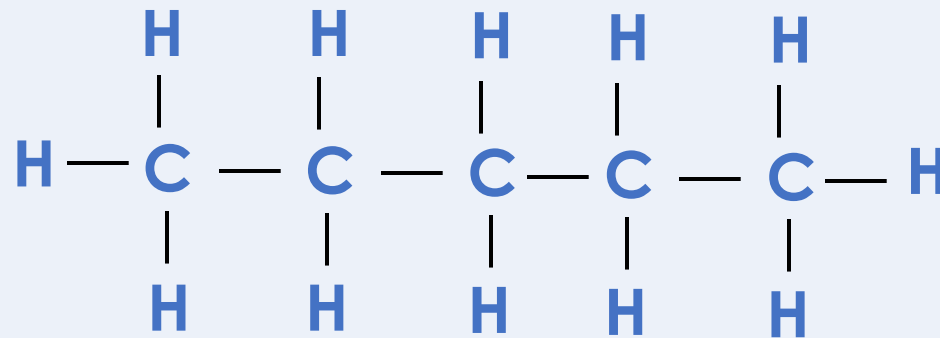
*Balance the symbol equation.*



## You: Combustion Reactions

Pentane ( $\text{C}_5\text{H}_{12}$ ) burns in air.

*Draw the structural formula for pentane.*



*Write a word equation for the combustion of pentane.*

**Pentane + oxygen  $\rightarrow$  carbon dioxide + water**

*Write a symbol equation for the combustion of pentane.*



*Balance the symbol equation.*



## Answer the questions below.

1. Which is the correct general equation for the combustion of alkanes?
  - ☐ A. Alkane + water  $\rightarrow$  oxygen + carbon dioxide
  - ☒ B. Alkane + oxygen  $\rightarrow$  water + carbon dioxide
  - ☐ C. Alkane + air  $\rightarrow$  water + carbon dioxide
2. Which is an advantage of burning hydrocarbons?
  - ☒ A. It releases lots of energy
  - ☐ B. It releases carbon dioxide
  - ☐ C. It releases water
3. When does incomplete combustion take place?
  - ☒ A. If there is not enough oxygen
  - ☐ B. If there is not enough alkane
  - ☐ C. If there is not the same amount of alkane and oxygen

## Lesson C5.1.4

What was good about this lesson?

What can we do to improve this lesson?

[Send us your feedback by clicking this link](#)  
or by emailing [sciencemastery@arkonline.org](mailto:sciencemastery@arkonline.org)  
Thank you!