Hydrocarbons are made up of **hydrogen** and **carbon** atoms

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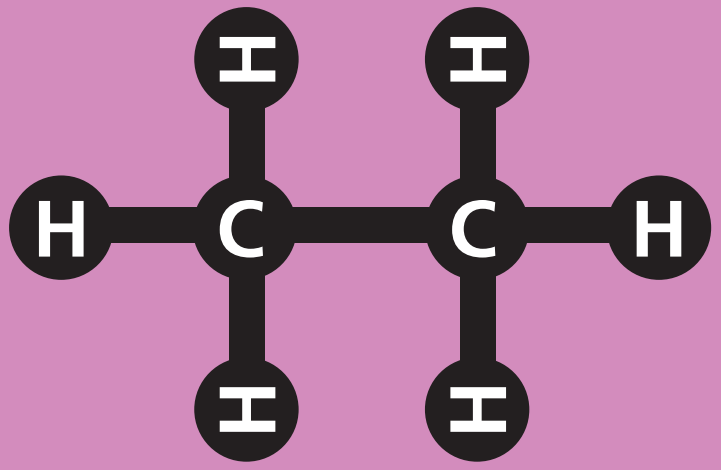
working with chemicals

Carbon can connect to hydrogen like this:



The chemical formula is:

Two atoms of carbon. C_2H_6 Six atoms of hydrogen.

These are called straight chain molecules.

How is the number of *carbon atoms* related to the number of *hydrogen atoms*?

Many simple molecules of **hydrogen and carbon** are **liquids and gases** that we extract from the earth and then **refine for fuel**.

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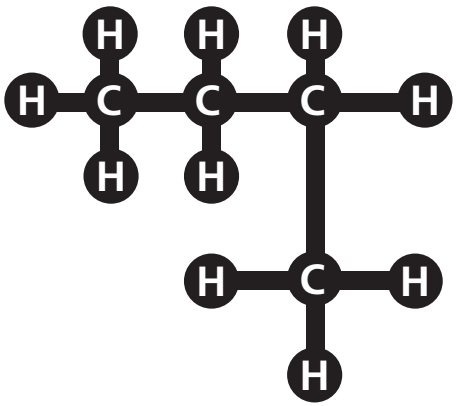
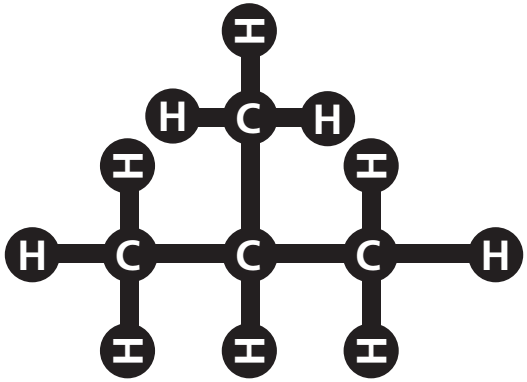
Each of these **molecules** has the same chemical formula C_4H_{10}

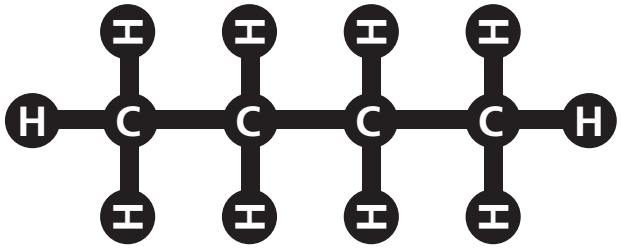
...but there are two different isomers.

Molecules which have the same chemical formula but a different structure, are called

ISOMERS







Two are butane. One is isobutane. Which is which?

How many *isomers* of C_5H_{12} and C_6H_{14} can you find?

There are **two** common forms of pure carbon, **graphite** and **diamond**, and both have many uses in industry – in making steel, high temperature lubricants and for cutting.

Scientists discovered new forms of pure carbon in 1985 while exploring deep space using radio telescopes.

The most common form usually had 60 carbon atoms and they believed its structure was spherical.

Can you discover a **3-dimensional** shape which has exactly 60 vertices?

The shape is made of regular pentagons and regular hexagons.

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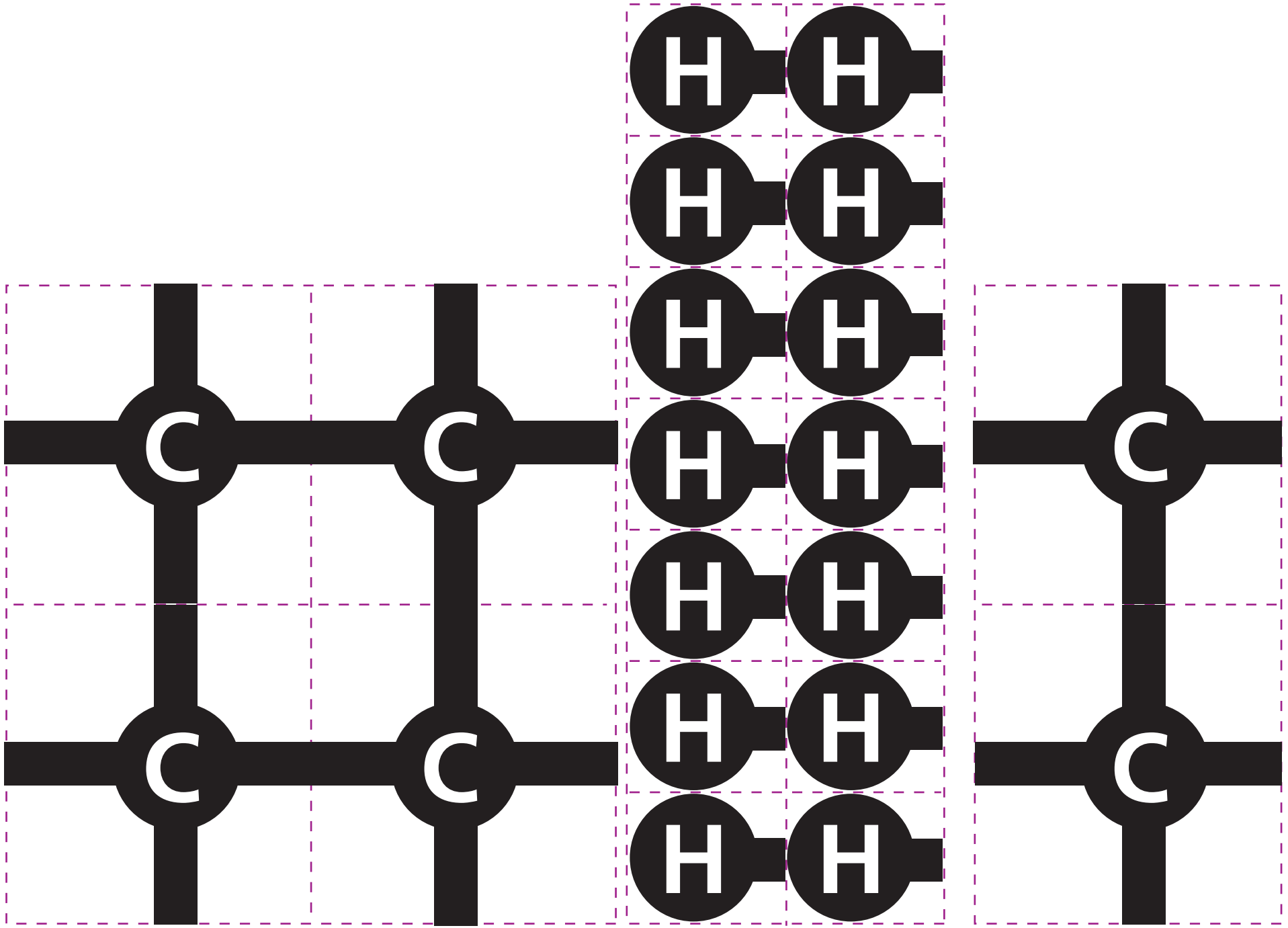
H H
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Teacher notes

Working with chemicals : Making molecules

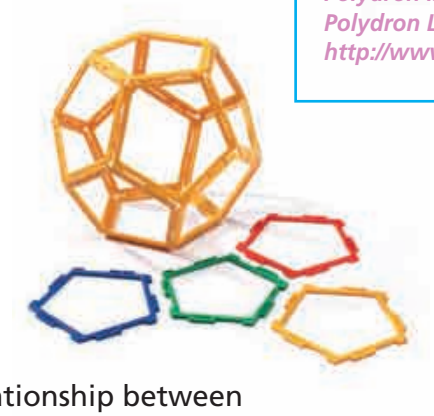
Description

This topic looks at the mathematical structure of some molecules.
No previous knowledge of chemistry is needed.

Activity 1: Hydrocarbons

Activity 2: Isomers

Activity 3: Carbon 60

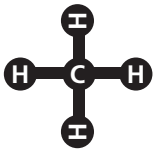


Resources

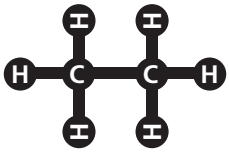
Polydron is available from Polydron Ltd http://www.polydron.co.uk

Hydrocarbons challenges your pupils to find a numerical relationship between the carbon and hydrogen atoms in a straight chain hydrocarbon molecule. Most will start by finding a number pattern. They can be encouraged to describe this in words or with a general formula C_nH_{2n+2}.

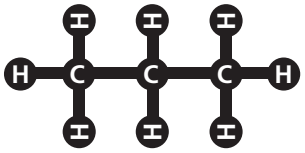
Here are the first three straight chain hydrocarbons:



CH_4 (methane)



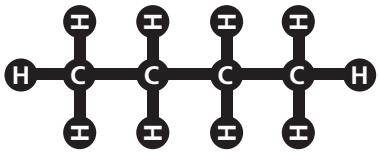
C_2H_6 (ethane)



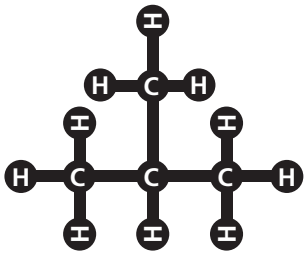
C_3H_8 (propane)

The next few in the sequence are butane C_4H_{10}; pentane C_5H_{12}; hexane C_6H_{14}; heptaneC_7H_{16} and octane C_8H_{18}.

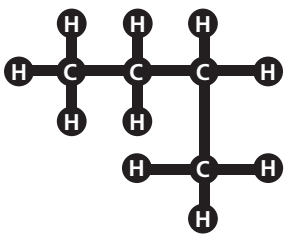
Isomers explores other ways of combining carbon and hydrogen atoms which do not result in straight chain hydrocarbons. It begins by asking the pupils to recognise that different 2-D representations **may** or **may not** stand for the same 3-D molecule.



C_4H_{10} (butane)



C_4H_{10} (isobutane)



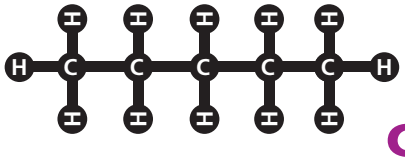
C_4H_{10} (butane)

Ask them to explain how butane and isobutane are structurally different.

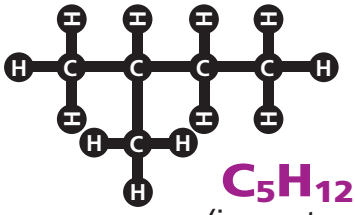
Working with chemicals : Making molecules

The activity then goes on to challenge pupils to find all the isomers of C_5H_{10} (pentane) and C_6H_{12} (hexane). They may want to experiment with the carbon and hydrogen atoms from the Isomers cut up sheet. Encourage your pupils to work systematically and to develop their own strategies for ensuring that they have not missed out any possibilities. Discussion in a small group will be effective in supporting this thinking. There are 3 isomers of C_5H_{12} and 5 isomers of C_6H_{14}. You may want to offer this information as a further prompt to help them realise that if two molecules are simple rotations or reflections of each other, they are not different.

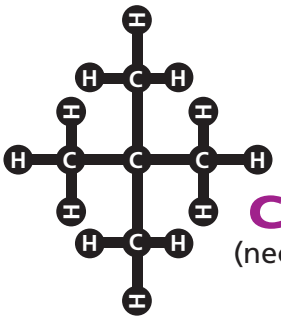
There are **3** isomers of C_5H_{12}



C_5H_{12}
(ethane)

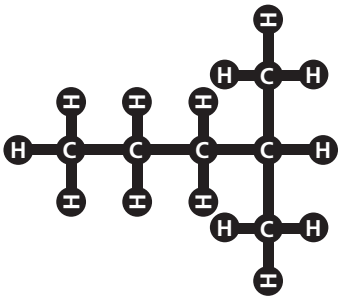


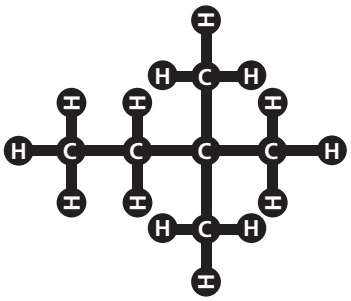
C_5H_{12}
(isopentane)

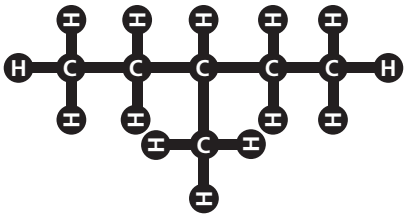


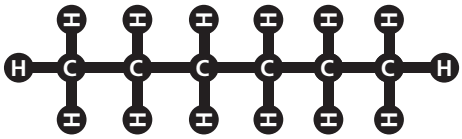
C_5H_{12}
(neopentane)

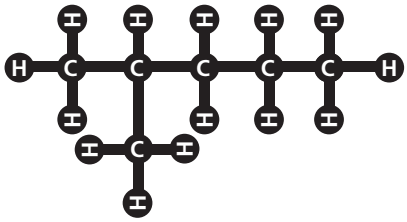
There are **5** isomers of C_6H_{14}











Working with chemicals : Making molecules

In Carbon 60 pupils explore the mathematical structure of the 'Buckyball' (also known as the Buckminster-Fullerine molecule). This shape is known as a truncated icosahedron. Two alternatives are offered:

- Ask your pupils to work in groups to try to find ways to make a molecule with 60 vertices (with each vertex representing the position of one carbon atom) using regular pentagons and hexagons. This is best done with Polydron. Give each group 12 pentagons and 20 hexagons.
- Ask your pupils to make up the shape from its net, available from http://mathworld.wolfram.com/pdf/TruncatedIcosahedron.pdf

  Here the task of finding out how hexagons and pentagons might be connected to make a spherical structure is removed. Pupils can, however, examine the completed structure and establish its properties.

The Mathematics

Hydrocarbons involves number pattern and simple algebra. Isomers requires pupils to work within a constrained mathematical structure and to consider the completeness of their solutions. In Isomers they will also consider ideas of reflection and rotation. Carbon 60 engages pupils in thinking in three dimensions.