Nat 4/5 Chemistry .
St Luke's High School

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Oil Strike!

Photograph: Kent Kobersteen/Getty

Topic 6 Oil Strike!

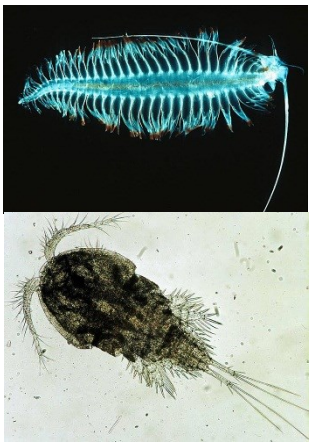
☐ Nat 4 outcomes O Nat 5 outcomes

By the end of this unit you should know the following:

- ☐ Fossil fuels come from the decayed and fossilised remains of plants and animals that lived millions of years ago, they are a finite resource.
- ☐ Crude oil is a mixture of hydrocarbons and fractional distillation is used to separate crude oil into useful fractions.
- ☐ The uses of each fraction and be able to explain changes in boiling point, ease of evaporation, flammability and viscosity for each fraction.
- ☐ Energy is released during burning/oxidation. Hydrocarbons burn in a plentiful supply of oxygen to produce carbon dioxide and water. Carbon monoxide, a poisonous gas, and carbon are produced when hydrocarbons burn in a limited supply of oxygen.
- ☐ Exothermic chemical reactions produce energy and endothermic chemical reactions take in energy. Combustion is an example of an exothermic reaction.
- ☐ Hydrocarbon molecules contain carbon and hydrogen only. The alkanes are a subset of hydrocarbons and are identified from the '-ane' ending. Straight-chain and branched alkanes can be named and identified from full structural formulae and molecular formulae up to C_8.
- ☐ Cracking is used to meet the demand for shorter chain alkanes and alkenes.
- O The alkenes are also a subset of hydrocarbons. An alkene can be identified from the carbon-to-carbon double bond and '-ene' ending. Straight-chain and branched alkenes can be named and identified from full structural formulae and molecular formulae up to C_8.
- O The cycloalkane family is a homologous series of hydrocarbons and is identified from the name and the general formula. Cycloalkanes, with no more than eight carbon atoms in their longest chain, are named from their full structural formulae, shortened structural formulae and molecular formulae.
- O Structural formulae can be drawn and molecular formulae written from systematic names.
- O Isomers including alkanes, branched alkanes, alkenes, branched alkenes and cycloalkanes. Isomers have different properties.
- ☐ The benefits and risks of different energy sources and their impact on the carbon cycle can be researched.
- ☐ Biomass, a source of biofuels, is plant-based material which can be burned to release energy. Biomass can also be converted to other usable forms of fuel. These include methane gas or fuels used for transportation such as ethanol and biodiesel.

1 Crude Oil

So why is oil so important to our modern lifestyle? Oil, or rather crude oil is a very complex mixture of chemical compounds called hydrocarbons. **The majority of these compounds get burnt to produce energy**, but some are used for other things such as the **starting chemicals for the formation of plastics, medicines and even explosives**.



Formation of Crude Oil

Crude oil formed over millions of years from the decaying remains of tiny marine organisms like plankton. As these remains fell to the bottom of the warm seas they became covered in layers of mud that over millions of years hardened into rock. The effect of heat and pressure over the millennia caused the decaying matter to turn into oil. **Crude oil is known as a fossil fuel** because it was formed from the remains of once living creatures over millions of years, just like fossilised dinosaur bones.

Extraction of Crude Oil

Different rock types and the movement of the Earth's crust caused the crude oil to collect in giant traps deep underground. Geologists try and locate these traps for oil companies and then these companies have to drill down into the rock, sometimes for many kilometres, to extract the oil.

RESEARCH TASK

After discussion with your teacher and others, find suitable sources of information on the formation and extraction of crude oil from the North Sea. Also try to make a list of all the uses the products of crude oil get put to.

Crude oil is a very complex mixture of many hundreds of compounds called hydrocarbons. The mixture needs to be **separated using a process called fractional distillation.**

ACTIVITY 6.1 Fractional Distillation

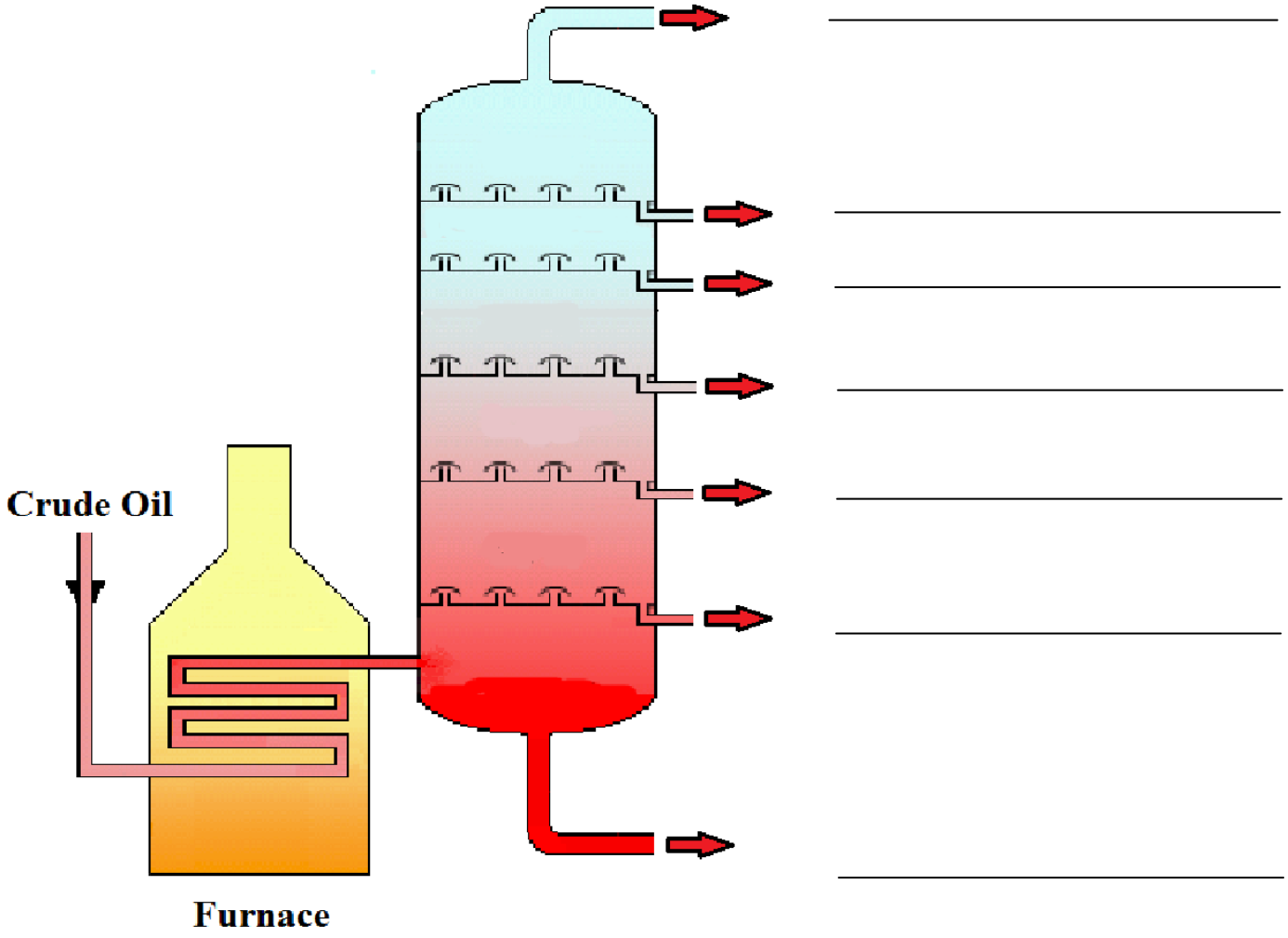
Your teacher may demonstrate the fractional distillation of some synthetic crude oil, or show you a video to explain how the process works in industry.

DISCUSS

After discussion with your teacher and others, can you explain how the process of fractional distillation works and what the different fractions are called?

NOTES

Complete the following diagram by naming the fractions:



The fractions are separated by the difference in their _____ _____ ranges.

Properties of the Fractions

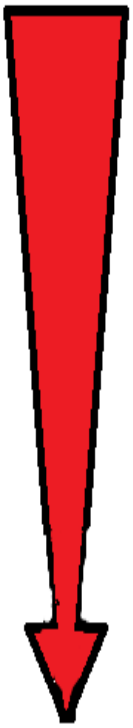
The hydrocarbons are made up of chains of carbon atoms of different lengths, some with only one or two carbon atoms; others with over 70 carbon atoms. The hydrocarbons making up the fractions coming off the top of the tower are the shortest ones; as we go down the column the chains get longer and longer. **The length of the chain affects the physical properties of the fractions**.

DISCUSS

After discussion with your teacher and others, can you explain how the properties of the fractions change as you go down the column, from the gas fraction to the residue.

NOTES

Complete the following diagram by showing how the properties of the fractions change as you go down the column from the gas fraction to the residue:

Name	Chain Length	Molecular Mass	Boiling Point	Ease of Evaporation	Flammability	Viscosity
	Short			Easy		Runny
Gas						
Gasoline						
Naphtha						
Kerosene						
Diesel Oil						
Fuel Oil						
Residue						
	Long				Low	

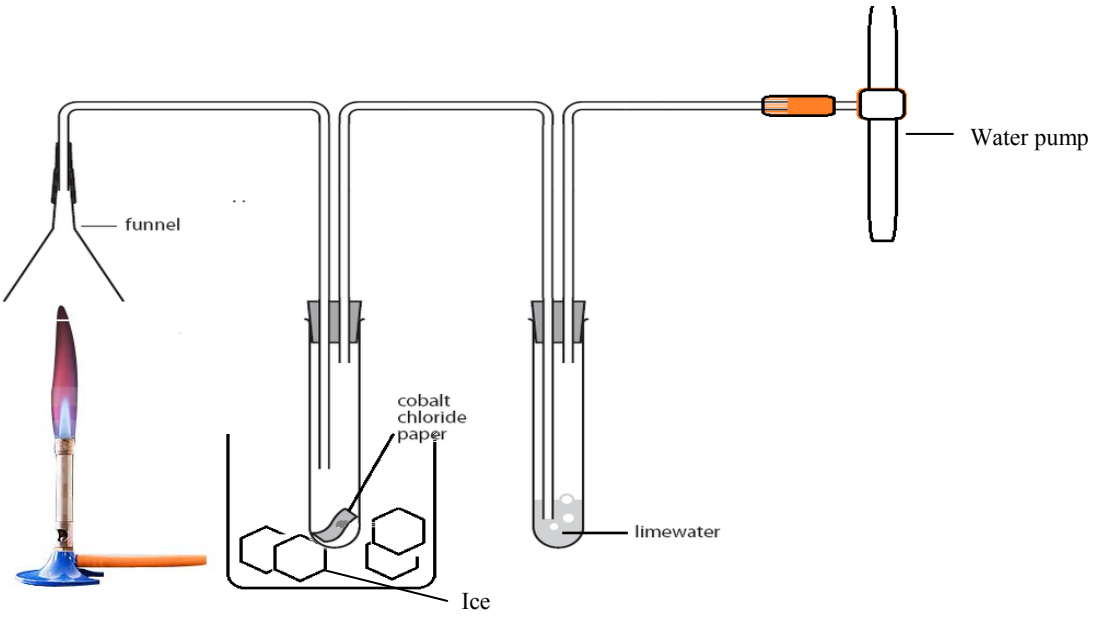
2 A Source of Energy

Global crude oil production is over 80 million barrels a day, a barrel of oil is nearly 160 litres. That's an awful lot of oil. Over 75% of it gets burnt either as fuels for transport or for heating. This is because crude oil is an excellent source of energy.

The chemical name for burning is combustion. When a fuel is burnt, **oxygen reacts with the elements making up the fuel and oxides of these elements are formed** as products.

ACTIVITY 6.3 Products of Complete Combustion

Your teacher may demonstrate how the products of combustion can be identified by setting up the following apparatus:



DISCUSS

After discussion with your teacher and others, can you explain how the two products of the complete combustion of methane, a hydrocarbon, were identified?

NOTES

Product of the complete combustion of methane	Test used and the result

So when a hydrocarbon completely burns in oxygen it forms the oxides, carbon dioxide and hydrogen oxide (water).

Hydrocarbon + oxygen → carbon dioxide + water

DISCUSS

After discussion with your teacher and others, can you identify the products of the complete combustion of different fuels?

NOTES

Complete the following table:

Fuel	Products of Combustion	
Petrol (C_8H_{12})		
Hydrogen (H_2)		
Coal (C)		
Ethanol (C_2H_5OH)		

If there is insufficient oxygen to completely burn a fuel, incomplete combustion occurs and carbon in the form of soot and the poisonous gas carbon monoxide can form.

NOTES

Complete the following table:

Product of Incomplete Combustion	Health Issues for Humans

Measuring the Energy

When a **fuel burns it releases energy, this is known as an exothermic reaction**, the opposite of this is **a reaction that takes in energy, this is known as an endothermic reaction**.

ACTIVITY 6.5 Exothermic & Endothermic Reactions

Your teacher may demonstrate some exothermic and endothermic reactions:

DISCUSS

After discussion with your teacher and others, can you tell the difference between an exothermic and endothermic reaction?

NOTES

Complete the following table:

Type of Reaction	Example
Exothermic	
Endothermic	

It is possible to measure the amount of energy released during burning by heating up water. Chemists know that it takes **4.18kJ of energy to raise the temperature of 1kg water by 1^0C**. This is known as the **specific heat capacity of water**.

This leads to the following equation:

$Eh = cm\Delta T$ where Eh = energy gained by the water

c = specific heat capacity of water = 4.18 $kJ^0C^{-1}kg^{-1}$

m = mass of water (1 litre = 1kg)

ΔT= change in temperature of water

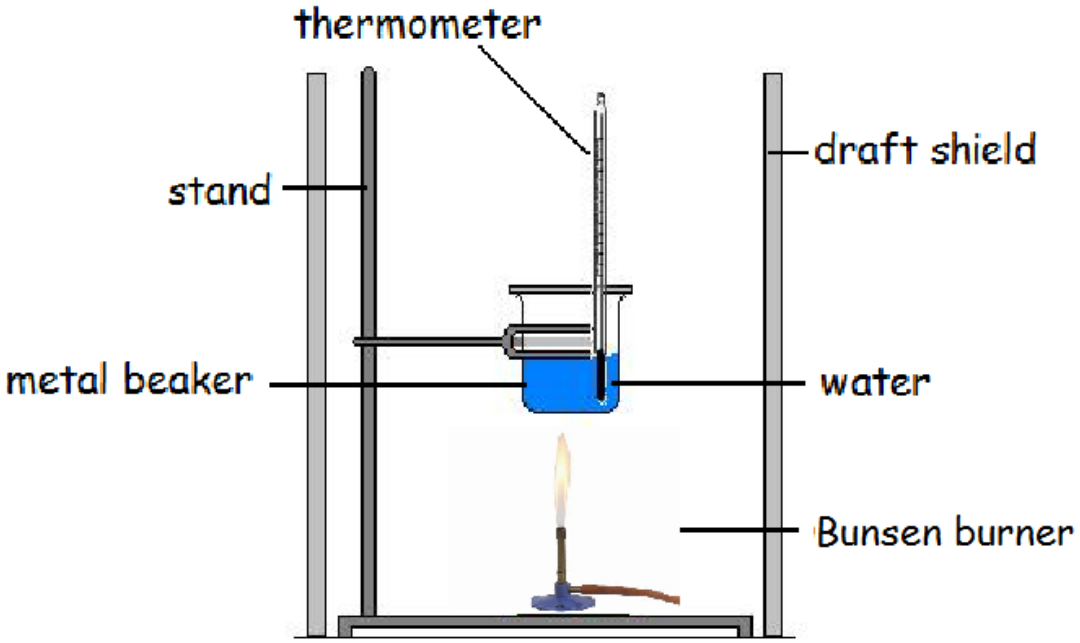
You can calculate the amount of energy produced by burning a fuel if you know the mass of water being heated and what the temperature rise is.

ACTIVITY 6.6 Measuring the Energy

After discussion with your teacher and others and using the diagram on the next page to help can you plan an investigation into which type of Bunsen burner flame produces the most energy; the safety flame, a gentle blue flame or a roaring blue flame?

ACTIVITY 6.6 Measuring the Energy

After discussion with your teacher and others and using the diagram on the next page to help can you plan an investigation into which type of Bunsen burner flame produces the most energy; the safety flame, a gentle blue flame or a roaring blue flame?



Flame	Mass of water (kg)	Start Temp (^0C)	End Temp (^0C)	Temp change (^0C)	Energy Released (kJ)
Safety Flame					
Gentle Blue Flame					
Roaring Blue Flame					

Show your calculations

Quick Test 1

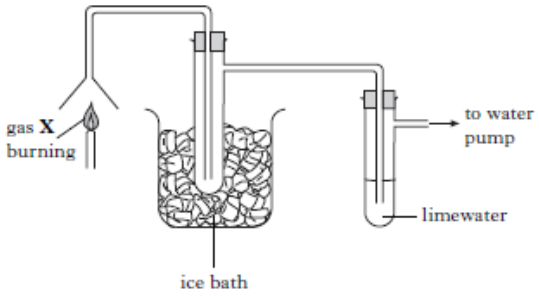
1. The fractional distillation of crude oil depends on the fact that different hydrocarbons have different

A. densities
B. solubility's
C. boiling points
D. ignition temperatures.

2. A compound burns in air. The only products of the reaction are carbon dioxide, sulfur dioxide and water vapour.
The compound **must** contain

A. carbon and hydrogen only
B. carbon and sulfur only
C. hydrogen, nitrogen and sulfur
D. carbon, hydrogen and sulfur.

3. The apparatus shown can be used to identify what is produced when a gas is burned.



When gas X was burned a colourless liquid was collected in the cooled test tube but there was no change to the limewater.
Gas X could be

A. carbon hydride
B. hydrogen
C. carbon monoxide
D. nitrogen.

4. The properties of fractions obtained from crude oil depend on the size of the molecules in the fraction.
Compared to a fraction with small molecules, a fraction containing large molecules will

A. be more viscose
B. be more flammable
C. evaporate more easily
D. have a lower boiling point.

3 What is Crude Oil Made Of?

As we have already seen crude oil is made up of a mixture of hydrocarbons. The simplest of these are found in the gas fraction.

The gas fraction contains the hydrocarbons **methane, ethane, propane and butane**. They are members of a group of hydrocarbons called **alkanes**. You can see that they all have the same ending –ane, the prefix before that tells you the number of carbon atoms in the molecule. The following mnemonic can help you to remember the first 8 prefixes:

Number	Prefix	Mnemonic
1	**m**eth-	**m**onkeys
2	**e**th-	**e**at
3	**p**rop-	**p**eeled
4	**b**ut-	**b**ananas
5	**p**ent-	**p**rivately
6	**h**ex-	**h**ating
7	**h**ept-	**h**airy
8	**o**ct-	**o**nes

Alkanes are a group of hydrocarbons that are made up of chains of carbon atoms joined together by single covalent bonds. Each carbon atom has the maximum number of hydrogen atoms that can bond to it and they are often described as being **saturated**. The alkanes are known as **a homologous series, where each member has the same general formula and similar chemical properties**.

Alkanes have a general formula given by:

C_nH_{2n+2} where n =the number of carbon atoms given by the prefix

The Structure of Alkanes

ACTIVITY 6.7 The Structure of Alkanes

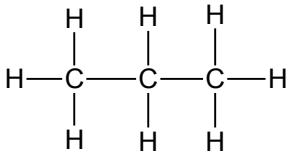
After discussion with your teacher and others use a Molymod kit to make the first 5 members of the alkanes.

There are three ways that we can show the structure of alkanes:

- Full Structural Formula - This shows all the atoms and the bonds they make.
- Shortened structural formula - This shows what is attached to each carbon atom.
- Chemical or molecular formula - This just shows the number of each type of atom.

For example: Propane

Full Structural Formula



Shortened Structural Formula $CH_3CH_2CH_3$

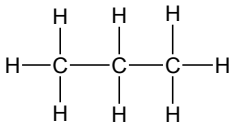
Molecular Formula C_3H_8

DISCUSS

After discussion with your teacher and others, make sure you can draw the different types of structure for the first eight members of the alkanes.

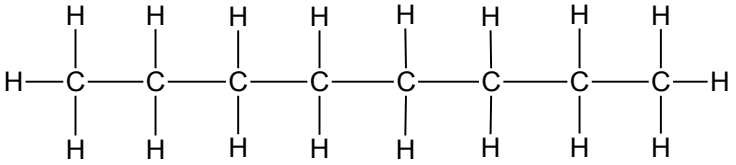
NOTES

Complete the following table:

Name	Full Structural Formula	Shortened Structural Formula	Molecular Formula
methane			
ethane			
propane		$CH_3CH_2CH_3$	C_3H_8
butane			

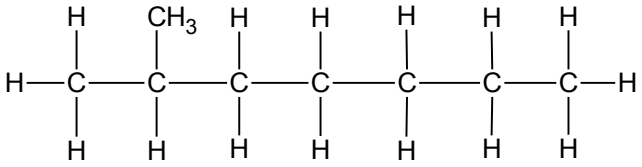
Same Formula, Different Structure

Octane is the main component in petrol, but to improve the way it burns chemist have found a way to change its structure, called catalytic reforming. This process causes the carbon atoms to rearrange themselves making a shorter chain but with carbon atoms attached to the side of the chain, called branches.



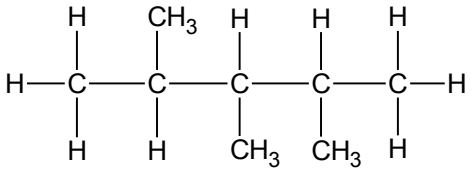
C_8H_{18}

Catalytic Reforming



C_8H_{18}

When you have hydrocarbons with the **same formula but a different structure**, they are known as **isomers**. Isomers can be made by shortening the chain length and adding branches.



C_8H_{18}

DISCUSS

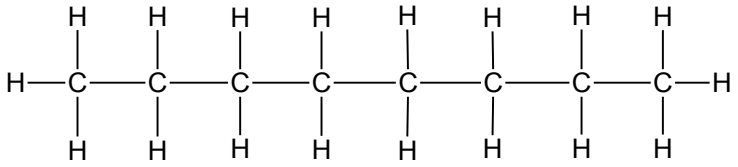
After discussion with your teacher and others, make sure you can draw different isomers and recognise when two molecules are isomers of each other.

NOTES

Draw the full structural formulae of the 3 isomers of C_5H_{12} in the space below:

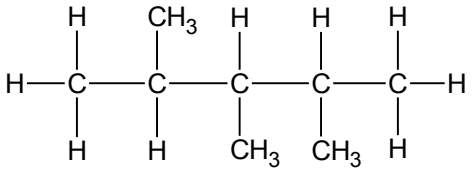
Naming Hydrocarbons

Isomers all have the same chemical formulae but because they have different structures we need to be able to identify them from their name. Octane has the chemical formula C_8H_{18} and has the following structure:



C_8H_{18}

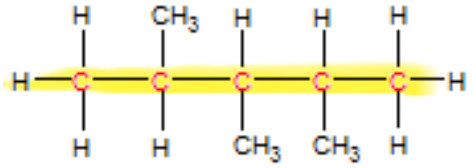
But the following molecule also has the chemical formula C_8H_{18}:



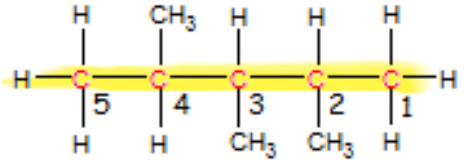
C_8H_{18}

We need a way of naming it so that we can draw the right structure. Chemist use a method called **systematic naming**:

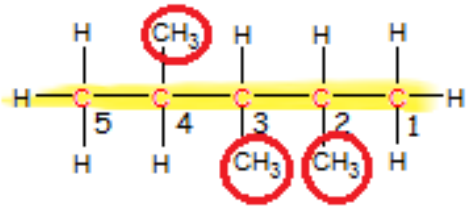
Step 1 Identify the longest continuous chain of carbon atoms. **(5 = pentane)**



Step 2 Number the carbons atoms starting at the end carbon nearest a branch.



Step 3 Identify the position of, number of and type of branches, if there is one carbon atom in a branch it is called a methyl, if two ethyl. If there are 2 branches its di-, if 3 branches tri-.**(2,3,4 trimethyl)**



Step 4 Name the structure starting with the branches and then the length of the alkane chain:

2,3,4-trimethyl pentane

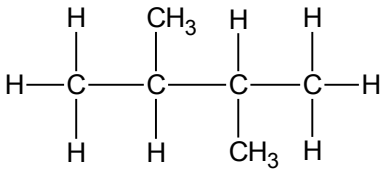
DISCUSS

After discussion with your teacher and others, make sure you can systematically name different branched alkanes and draw full structural formulae from a systematic name.

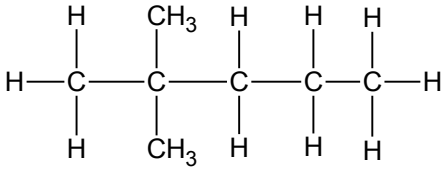
NOTES

Name the following branched alkanes:

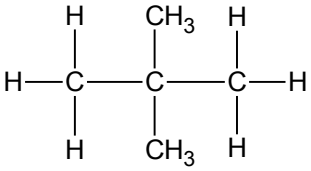
A.



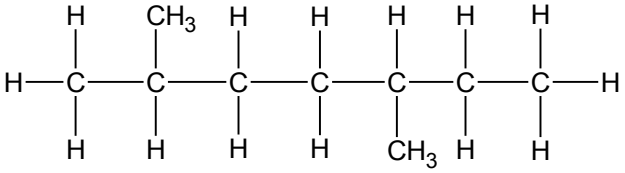
B.



C.



D.



Draw the full structural formulae of the following hydrocarbons:

A. 2,4-dimethylhexane

B. 2,2,3-trimethylbutane

C. 3-methylheptane

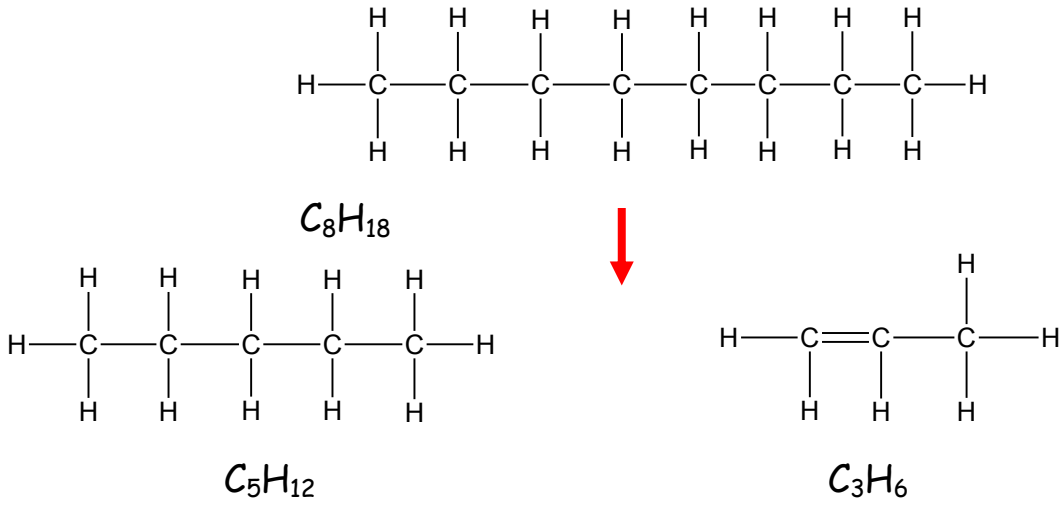
D. 2-methylpropane

4 Getting the Most From Oil

The vast majority of the fractions from crude oil are used as fuels, but some fractions produce more desirable fuels than others. The fuel in the greatest demand is petrol and the one in least demand is fuel oil. Chemists have therefore found a way to turn longer less useful hydrocarbons into shorter more desirable ones. As an added bonus this process also produces chemicals that can be used to produce a whole range of important substances such as plastics, medicines, paints, solvents and even explosives.

Cracking

This is the name given to the process that splits the long chain hydrocarbons into smaller more useful ones. Shown below is an example of how octane can be broken up into two smaller hydrocarbon compounds:



The chemical equation for this process is:

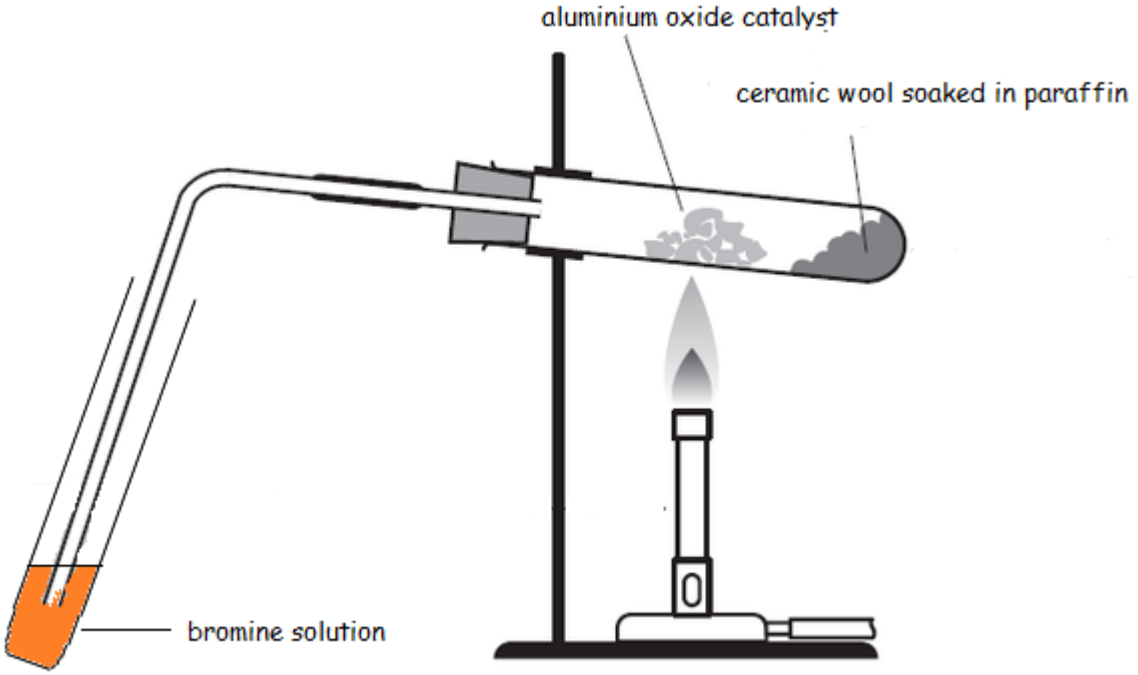
$$C_8H_{18} \rightarrow C_5H_{12} + C_3H_6$$

Notice that the number of carbon atoms and hydrogen atoms on each side of the equation are the same. In order for this to occur one on the molecules has two less hydrogen's than a normal alkane and has a carbon to carbon double bond, so that each carbon atom has the right number of bonds. **This is because there are insufficient hydrogen atoms to form two alkanes.**

This type of hydrocarbon is called an alkene and it also described as being **unsaturated**.

ACTIVITY 6.8 Cracking

Your teacher will demonstrate to you how to set up the following apparatus and how you can safely crack paraffin.



The changing of the orange bromine solution to colourless indicates the presence of alkenes in the product mixture.

DISCUSS

After discussion with your teacher and others, make sure you can explain why the clamp should not be too tight and how to prevent suck back.

NOTES

In the space below write down the two important safety precautions you took whilst cracking the paraffin.

1. _____

_____

_____

2. _____

_____

_____

When paraffin is cracked a mixture of hydrocarbons are formed. This is because each paraffin molecule can break between different carbon atoms and sometimes break in more than one place. For each individual molecule however the products of cracking must always have the same number of carbon and hydrogen atoms as the original paraffin molecule.

E.g.

$C_{12}H_{26} \rightarrow C_8H_{18} + C_4H_8$

or

$C_{12}H_{26} \rightarrow C_6H_{14} + C_6H_{12}$

or

$C_{12}H_{26} \rightarrow C_5H_{12} + C_4H_8 + C_3H_6$

DISCUSS

After discussion with your teacher and others, make sure you can work out the products of cracking.

NOTES

Complete the following chemical equations showing **different** products of cracking to those given above:

1. $C_{12}H_{26} \rightarrow$ +

2. $C_{12}H_{26} \rightarrow$ + +

The Structure of Alkenes

ACTIVITY 6.9 The Structure of Alkenes

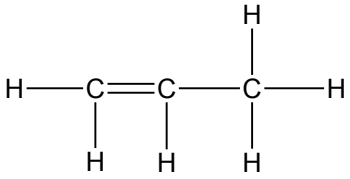
After discussion with your teacher and others use a Molymod kit to make the first 4 members of the alkenes.

As with alkanes there are three ways that we can show the structure of alkenes:

Full structural formula, shortened structural formula and chemical or molecular formula.

For example: Propene

Full Structural Formula



Shortened Structural Formula $CH_2=CHCH_3$

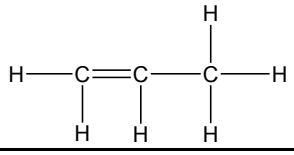
Molecular Formula C_3H_6

DISCUSS

After discussion with your teacher and others, make sure you can draw the different types of structure for the first eight members of the alkenes.

NOTES

Complete the following table:

Name	Full Structural Formula	Shortened Structural Formula	Molecular Formula
ethene			
propene		$CH_2=CHCH_3$	C_3H_6
butene			
pentene			

The alkenes are another homologous series, with members having the same general formula and similar chemical properties.

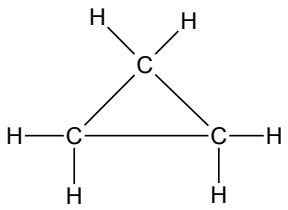
The general formula of the alkenes is C_nH_{2n}.

Cycloalkanes

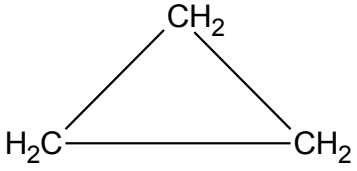
Cycloalkanes are another type of hydrocarbon that can be formed by a variety of chemical reactions in the petrochemical industry. Like alkanes **they are described as being saturated** as they contain only single bonds between the carbon atoms, but unlike alkanes **they form a ring structure**.

For example: cyclopropane

Full Structural Formula



Shortened Structural Formula



Molecular Formula C_3H_6

ACTIVITY 6.10 The Structure of Cycloalkanes

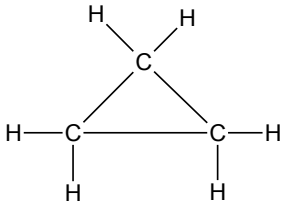
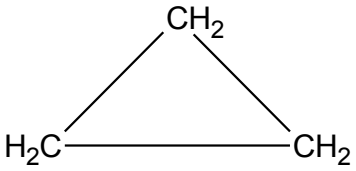
After discussion with your teacher and others use a Molymod kit to make the first 4 members of the cycloalkanes.

DISCUSS

After discussion with your teacher and others, make sure you can draw the different types of structure for the first eight members of the cycloalkanes.

NOTES

Complete the following table:

Name	Full Structural Formula	Shortened Structural Formula	Molecular Formula
cyclopropane			C_3H_6
cyclobutane			
cyclopentane			
cyclohexane			

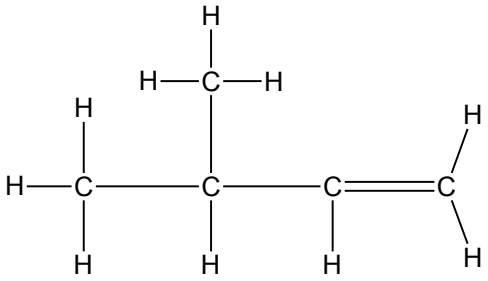
The general formula of the cycloalkanes is C_nH_{2n}.

They are a different homologous series to the alkenes as although they have the same general formula, they have different chemical properties.

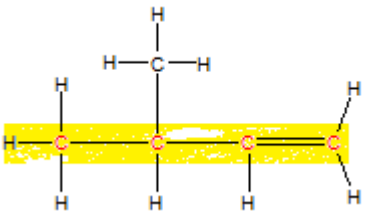
Naming Hydrocarbons Again

As with naming alkanes we can use systematic naming to name alkenes as well:

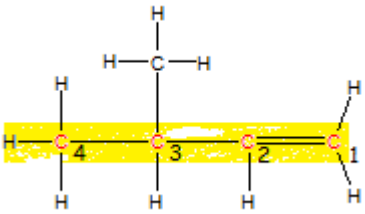
Take the following example:



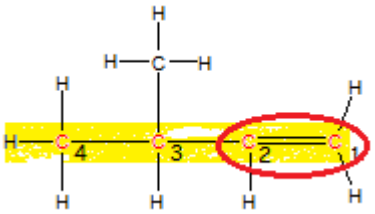
Step 1 Identify the longest continuous chain of carbon atoms. **(4 = but)**



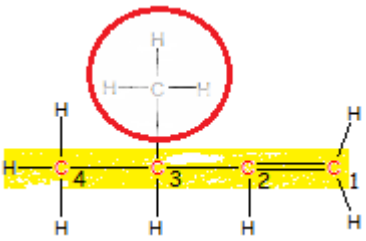
Step 2 Number the carbons atoms starting at the end carbon nearest the double bond.



Step 3 Identify the position of the double bond. **(-1-ene)**



Step 4 Identify the position of, number of and type of branches, if there is one carbon atom in a branch it is called methyl, if two ethyl. If there are 2 branches its di-, if 3 branches tri-.**(3-methyl)**



Step 5 Name the structure, starting with the branches, then the chain length and then the position of the double bond.

3-methylbut-1-ene

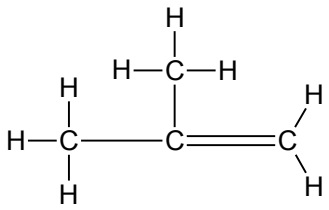
DISCUSS

After discussion with your teacher and others, make sure you can systematically name different branched alkenes and draw full structural formulae from a systematic name.

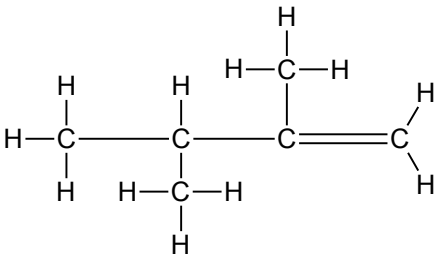
NOTES

Name the following branched alkenes:

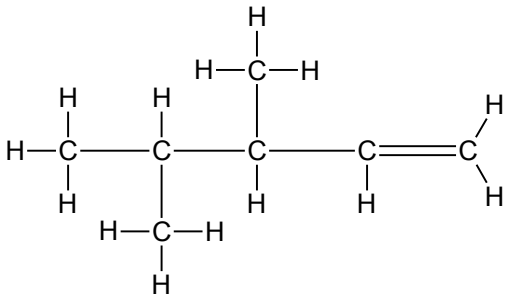
A.



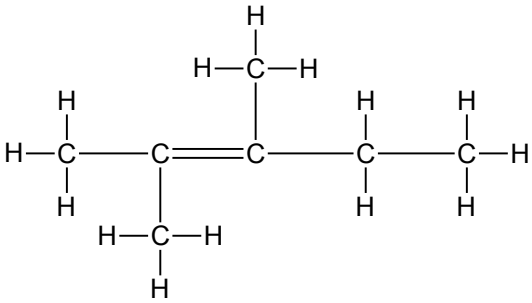
B.



C.



D.



Draw the full structural formulae of the following hydrocarbons:

A. 3,4-dimethylhex-2-ene

B. 2,3,3-trimethylbut-1-ene

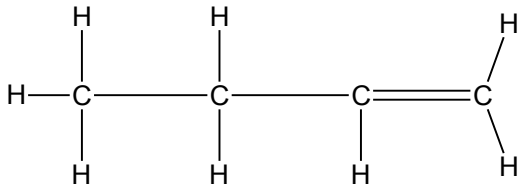
C. 4-ethylhept-2-ene

D. 4-methlypent-2-ene

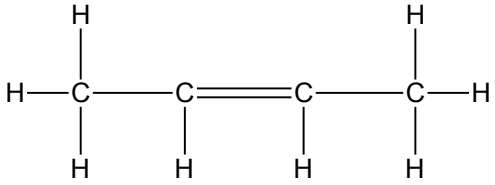
Isomers of alkenes

In the same way that alkanes could be made to form isomers, the alkenes can also form isomers. As before the **isomers can be made by shortening the chain length and adding branches,** but you can also **create isomers by moving the position of the double bond and creating cycloalkanes**.

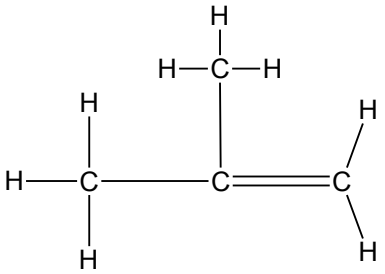
Example: Butene (C_4H_8)



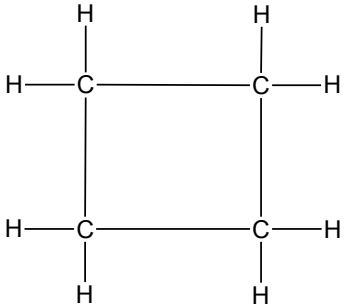
but-1-ene



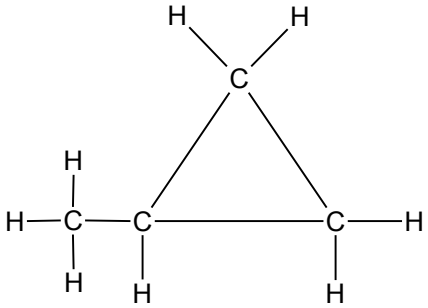
but-2-ene



methyl propene



cyclobutane



methyl cyclopropane

DISCUSS

After discussion with your teacher and others, make sure you can draw different isomers of alkenes and recognise when two molecules are isomers of each other.

NOTES

On a piece of paper draw the full structural formulae of as many isomers of C_5H_{10} as you can, once your teacher has checked them draw them in the space below:

We saw during the cracking experiment that alkenes can decolourise bromine solution. We can use this reaction to help identify whether a hydrocarbon is saturated or unsaturated.

ACTIVITY 6.12 Testing for Unsaturation

- Collect three test tubes and to each add 1 or 2 cm depth of either an alkane, alkene or cycloalkane.
- To each carefully add 10 drops of bromine solution.
- Put a rubber bung in the top and shake.
- Note which rapidly decolourises.
- Repeat the experiment but use the three unknown hydrocarbons labelled A, B and C.

NOTES

Complete the following tables:

Hydrocarbon	Saturated or unsaturated	Effect on bromine solution
Alkane		
Alkene		
Cycloalkane		

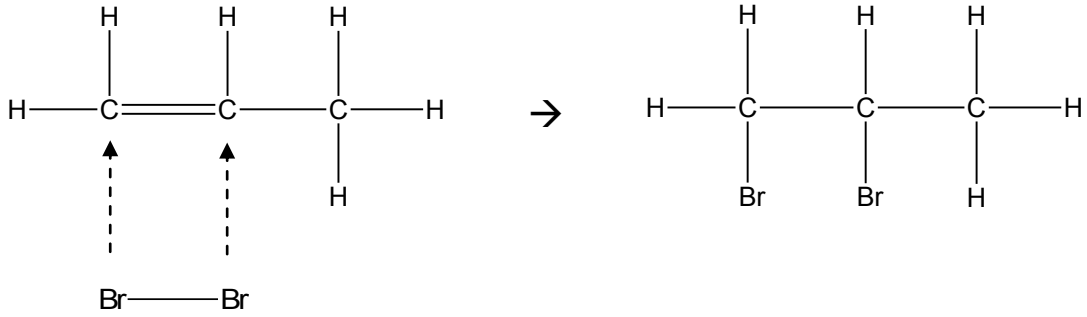
Hydrocarbon	Effect on bromine solution	Saturated or unsaturated	Suggested Structural Formula
A (C_6H_{14})			
B (C_6H_{12})			
C (C_6H_{12})			

Addition Reactions

The reaction of an unsaturated hydrocarbon with bromine solution is an example of an addition reaction. This is where the bromine molecule adds across the double bond causing it to form a single bond between the carbon atoms:

E.g. propane + bromine → dibromopropane

C_3H_6 + Br_2 → $C_3H_6Br_2$



Other small molecules can react with alkenes in a similar way, such as hydrogen, H_2, hydrogen chloride, HCl, and water, H_2O.

This simple process is the basis of the petrochemical industry where fractions from the fractional distillation of crude oil are cracked. The unsaturated hydrocarbons can be turned into plastics or using addition reactions turned into the feedstocks for a wide range of very important chemicals including solvents, paints, medicines and cosmetics.

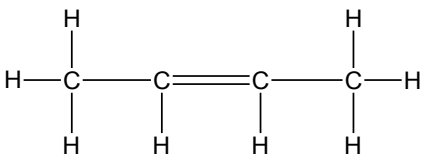
DISCUSS

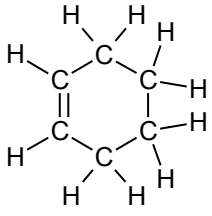
After discussion with your teacher and others, make sure you can work out and draw the products from simple addition reactions.

NOTES

Work out and draw the products of the following addition reactions:

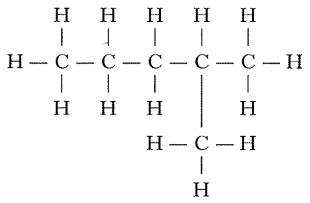
1. C_2H_4 + H_2O →

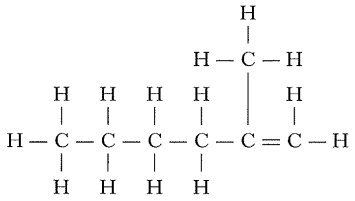
2.  + HCl →

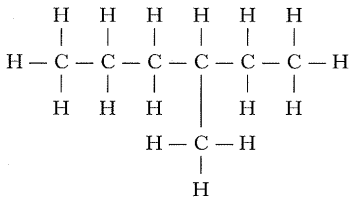
3.  + Br_2 →

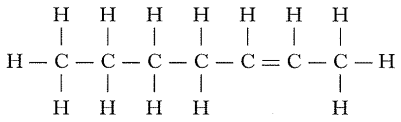
Quick Test 2

1. Which of the following is an isomer of heptane?

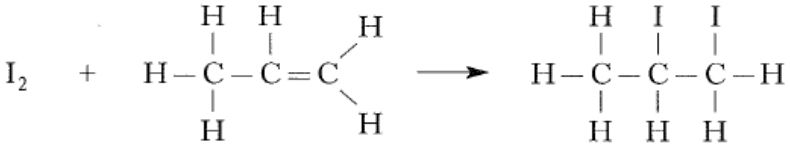
A 

C 

B 

D 

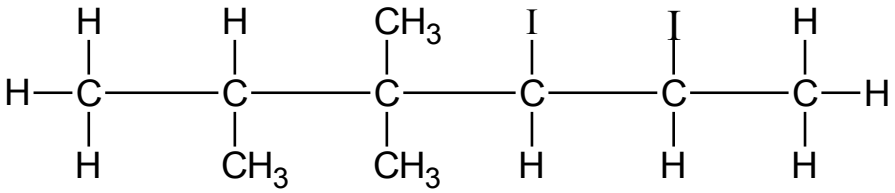
2. Iodine can react with propene in the following way.



a. Name the homologous series to which propene belongs

b. Name the type of chemical reaction which takes place when iodine reacts with propene.

c. In a similar reaction the following product is formed



i. Draw the structural formula for the starting alkene.

ii. Give the starting alkene's systematic name

5 Is There an Alternative?

Unfortunately there are problems associated with the burning of fossil fuels. In the previous topic on Acids you saw that burning fossil fuels is associated with the formation of acid rain. There is also an additional problem and that is the fact that whenever you burn a hydrocarbon, no matter how cleanly, you will always produce carbon dioxide. **Carbon dioxide has been linked by many scientists to global warming and climate change**.

DISCUSS

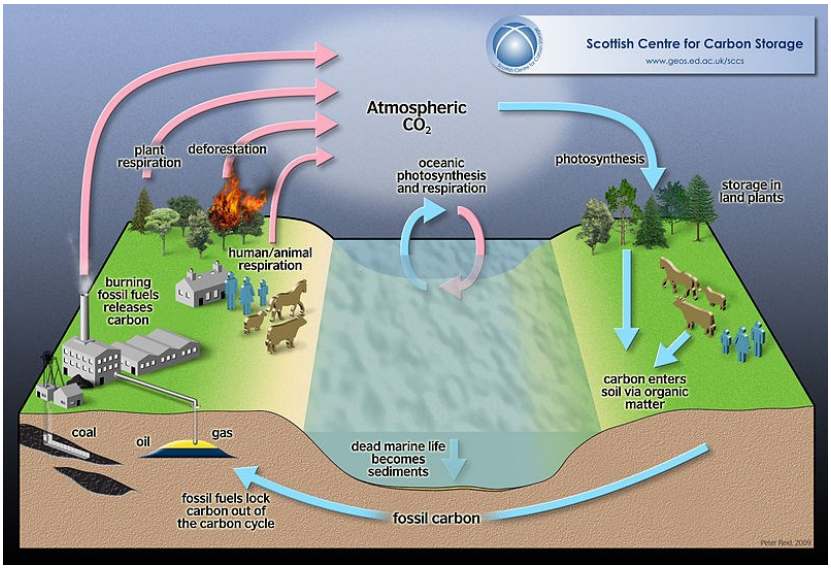
After discussion with your teacher and others, can you identify some of the major problems that the planet could face from global warming and climate change?

NOTES

Complete the following table showing the potential effect on our environment and society by global warming and climate change.

Potential effect on our environment from global warming & climate change	Potential effect on societies from global warming & climate change

The Carbon Cycle



The diagram shows how carbon is constantly moving in a cycle. Unfortunately the burning of fossil fuels is raising the level of carbon dioxide in our atmosphere far quicker than plants and trees can reabsorb it.

If we can reduce the amount of fossil fuels we burn, we will have less of a negative effect on the carbon cycle. But what are the alternatives?

Biofuels

Wood is an example of a biofuel, it is fuel that has recently being produced from a natural product that made its carbon structure from carbon dioxide in the air. When it burns it releases the same amount of carbon dioxide back into the atmosphere. As we can keep growing more wood it is described as an infinite or renewable resource.

Wood isn't very useful for powering car engines but there are other biofuels that are much better, some common examples are methanol, ethanol and biodiesel. Methane gas produced by decaying waste is another example which could be used in power stations.

DISCUSS

After discussion with your teacher and others, can you identify some examples of biofuels and what the advantage of using these as an alternative to fossil fuels like petrol might be?

NOTES

Complete the following table showing some examples of biofuels and the advantages they have as an alternative to fossil fuels like petrol.

Examples of biofuels	Advantage 1 of using biofuels	Advantage 2 of using biofuels

RESEARCH TASK

After discussion with your teacher and others, find suitable sources of information on how different biofuels are made and where they are used.

Its Never That Simple

You would think that as biofuels release the same carbon dioxide that they took in to grow, the burning of biofuels would not produce any "extra" carbon dioxide. Unfortunately its not as simple as that!

Harvesting, processing and distributing are all necessary activities that use energy and produce carbon dioxide, which means that you will still add to the carbon cycle problem. Some of the processes used to make the biofuel also require other chemicals, some quite toxic and unkind to the environment.

However the biggest drawback to the use of biofuels is that we require so much fuel, that if we use our land to grow crops for biofuels we can't grow enough crops to feed ourselves. This isn't such a problem in rich countries that can just buy in more food, but for poor countries the cost of food becomes so expensive the people cannot afford to eat! This has led to a lot of civil unrest in countries.

Karla Z. Bertrand, Greg Lindsay, Yaneer Bar-Yam http://necsi.edu/

DISCUSS

After discussion with your teacher and others, can you identify some of the disadvantages of using biofuels.

NOTES

In the space below write a short note on the main disadvantages of using biofuels.

6 Is it Worth it?

The discovery and use of crude oil in the 20th and 21st centuries has revolutionised the way we live our lives. From cheap and efficient transport to modern synthetics and fibres, there isn't an area of our modern lifestyle that doesn't hinge on the need for oil. But crude oil is a finite resource and as we use more and more of it, we will eventually run out. The need to find new supplies will become more and more important. We also know that the burning of fossil fuels is increasing the amount of carbon dioxide and other pollutants in our atmosphere.

DISCUSS

After discussion with your teacher and others, think of all the advantages and disadvantages of continuing to rely on crude oil.

NOTES

Complete the following table showing the advantages and disadvantages of our continuing reliance on using crude oil:

Advantages of using crude oil	Disadvantages of using crude oil

The Artic and the Antarctic are some of the last remaining wildernesses that have not been unduly affected by the drilling for oil. There is a real concern that the extreme nature of these areas will make the containment of an oil spill much more difficult to cope with in such harsh environments.