

**GENERAL CERTIFICATE OF SECONDARY EDUCATION
TWENTY FIRST CENTURY SCIENCE**

A323/02/RB

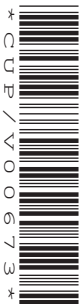
CHEMISTRY A

Unit 3: Ideas in Context plus C7
(Higher Tier)

RESOURCE BOOKLET

JUNE 2009

To be opened on receipt



INSTRUCTIONS TO CANDIDATES

- This booklet contains the article required to answer question 1.
- Take this article away and read it through carefully.
- Spend some time looking up any technical terms or phrases you do not understand.
- For the examination on **Thursday 4 June 2009** you will be given a fresh copy of this article, together with a question paper.
- You will **not** be able to take your original copy into the examination with you.

INFORMATION FOR CANDIDATES

- This document consists of **4** pages. Any blank pages are indicated.

The bioethanol dilemma

Life on Earth depends on energy from the Sun, which warms our atmosphere. But if too much energy is trapped by gases in the atmosphere, our globe warms up, and this can cause violent changes in the weather. Carbon dioxide from road vehicles is believed to add to this global warming.

28% of all carbon dioxide emissions in the United Kingdom come from the petrol and diesel burned by road traffic. The government is committed to a 20% reduction in these emissions by 2010. If the government is going to consider alternative fuels they need to carry out a whole Life Cycle Assessment for each fuel.

What is bioethanol?

Bioethanol is a fuel produced by fermentation of sugar. It is made from corn, maize, wheat or sugar beet. The plants absorb carbon dioxide from the air as they grow.

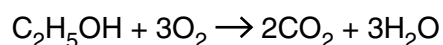
Most modern cars can use petrol with up to 5% of bioethanol added. Higher concentrations can only be used if car engines are modified.

The European Union (EU) recently issued a directive calling for biofuels to meet 5.75% of transport fuel needs by 2010. This table shows how use of bioethanol increased in some European countries during the years from 2005 to 2006.

| | bioethanol consumption (energy units) | |
|----------------|---------------------------------------|------|
| | 2005 | 2006 |
| Austria | 0 | 920 |
| France | 870 | 1750 |
| Poland | 330 | 610 |
| Spain | 1310 | 1330 |
| Sweden | 1680 | 1900 |
| United Kingdom | 500 | 560 |

Burning bioethanol

The mass of carbon dioxide produced by burning bioethanol can be calculated from this equation.



Burning pure bioethanol produces 70% less carbon dioxide than burning the same volume of petrol. Even putting just 5% bioethanol into petrol reduces the carbon dioxide released by 3.5%.

Burning bioethanol releases 34% less energy than burning the same volume of petrol. So, the 'miles per gallon' figure for a car would be reduced by about one-third, and it would need to refuel more often. Some scientists believe that using bioethanol rather than petrol reduces total emissions of carbon dioxide by only about 13% because of the pollution caused by the production process, and because bioethanol gets only about 70% of the mileage of petrol.

Using bioethanol can help reduce the amount of carbon monoxide and particulate carbon produced by vehicles, thus improving air quality.

Can we make enough bioethanol?

The UK grows a surplus of about 3.5 million tons of wheat each year. This could be used to make bioethanol without affecting the production of food. This wheat surplus could produce about 1 million tons of fuel, which is equivalent to 5% of the UK petrol market.

Most UK wheat crops are high starch varieties which give the highest bioethanol yield. One hectare of wheat would produce enough bioethanol to run an average car for about 30 000 miles and one lorry load of wheat will produce enough bioethanol for 100 000 miles of motoring.

Environmental benefits of using bioethanol as transport fuel

The UK Central Science Laboratory says that bioethanol requires 61% less energy to produce than petrol. Also less energy is used, and less pollution caused, when transporting it to the filling station.

Bioethanol is considered to be a sustainable material because it uses the Earth's resources in a way that can continue in the future. Photosynthesis absorbs carbon dioxide from the air as the fuel crops grow. The sugar produced is later processed into bioethanol. The carbon dioxide that was absorbed by the crops as they were grown is returned to the air as the bioethanol is burned. This cycle can be continued indefinitely.

Blending bioethanol with petrol will help extend the life of the UK's own oil supplies and reduce our dependence on other oil producing nations. Bioethanol is also biodegradable and far less toxic than fossil fuels.

This article continues on page 4.

What are the disadvantages of using bioethanol?

Growing crops to produce bioethanol would use a large area of cultivated land. It has been estimated that meeting the 5.75% EU target would use a quarter of the EU's arable land. Other concerns are a possible decline in soil fertility, a decrease in water availability and quality, and an increase in the use of fertilizers.

To obtain a large enough supply, the UK may need to import bioethanol. If bioethanol is imported from the USA, it will likely come from maize, which uses fossil fuels at every stage of production. Fossil fuels are used in cultivation, production of fertilizers, harvesting, processing and transportation. Growing maize appears to use 30% more energy than the bioethanol produces when used as a fuel.

As demand for bioethanol increases, food crops are replaced by fuel crops, driving food prices up. This leads to higher prices for animal products like chicken, beef, and cheese. Food prices are already increasing. With just 10% of the world's sugar harvest being converted to bioethanol, the price of sugar has doubled.

As more wheat is used to make bioethanol, the price of bread will rise.



The amount of grain required to make enough bioethanol to run one large car would feed the population of an African village.

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