

**To be opened on receipt****GCSE TWENTY FIRST CENTURY SCIENCE  
CHEMISTRY A****A323/01** Unit 3: Ideas in Context plus C7 (Foundation Tier)**RESOURCE BOOKLET****JANUARY 2013****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 17 January 2013** 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

The government is committed to reducing carbon dioxide emissions. Of all carbon dioxide emissions in the United Kingdom, 28% come from the petrol and diesel burned by road traffic.

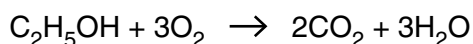
### Making bioethanol

Bioethanol is a fuel produced by fermentation. It is usually made from maize, wheat or sugar beet. 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.

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

### Using bioethanol

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



Burning pure bioethanol produces about two-thirds the amount of carbon dioxide that burning the same mass of petrol does. However, burning bioethanol releases less energy than burning the same mass of petrol. So the number of miles travelled per kilogram of fuel would be reduced by about one-third, and cars 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 produces about 70% of the mileage of petrol.

### 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.

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

As well as being a more sustainable fuel than petrol, bioethanol has other environmental benefits. The UK Central Science Laboratory says that bioethanol requires 61% less energy to produce than petrol.

Using bioethanol can also help reduce the amount of carbon monoxide and particulate carbon produced by vehicles, thus improving air quality. Bioethanol is also biodegradable and far less toxic than fossil fuels.

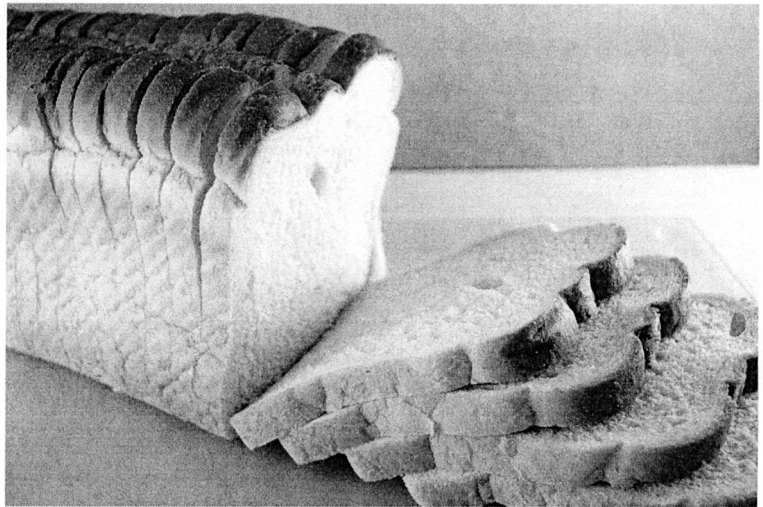
### What are the disadvantages of using bioethanol?

Growing crops to produce bioethanol would use large areas of cultivated 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.



It is possible to make bioethanol from waste biomass, such as wood chippings, paper and straw. In the future this may provide a more sustainable supply of bioethanol.

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