

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS**

**Advanced Subsidiary GCE**

**SCIENCE**

**2842**

Science and Human Activity

Thursday

**12 JANUARY 2006**

Morning

1 hour

Candidates answer on the question paper.

Additional materials:

Electronic calculator

Candidate Name	Centre Number	Candidate Number												
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**TIME** 1 hour

**INSTRUCTIONS TO CANDIDATES**

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces provided on the question paper.
- Read each question carefully to make sure you know what you have to do before starting your answer.

**INFORMATION FOR CANDIDATES**

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	8	
2	16	
3	8	
4	9	
5	10	
6	9	
<b>TOTAL</b>	<b>60</b>	

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**This question paper consists of 13 printed pages and 3 blank pages.**

Answer **all** the questions.

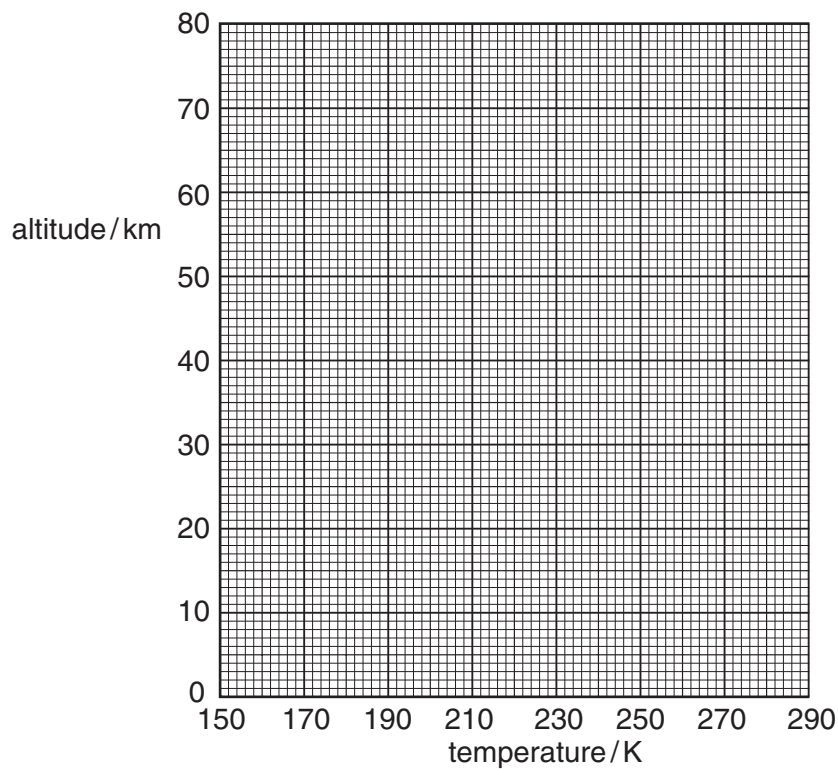
- 1 Remote sensing satellites have enabled scientists to gain much more information about the atmosphere, including data about how temperature and the concentration of molecules vary with altitude.

The following data were obtained from a remote sensing satellite.

altitude / km	temperature / K
0	279
10	253
20	234
30	248
40	259
50	285
60	270
70	243
80	175

- (a) Plot these data on the graph below.

Use a smooth curve to show the pattern in the data.



[2]

(b) The pattern of temperature change with altitude is related to the presence of ozone in the stratosphere. The stratosphere is separated from the troposphere by the tropopause.

(i) The presence of ozone causes the temperature in the stratosphere to increase. Explain why.

.....  
..... [2]

(ii) Use the graph to suggest

- the height at which ozone concentration is a maximum;

answer: ..... km

- the height of the tropopause.

answer: ..... km  
[2]

(c) Ozone makes up just 1% of the gases in the stratosphere. Name **two** gases present in the stratosphere in much larger quantities than ozone.

..... and ..... [2]

[Total: 8]

2 Nitrogen oxides from car exhausts cause air pollution.

(a) (i) Explain how nitrogen oxides are formed in car engines.

.....  
.....  
.....  
..... [3]

(ii) Explain one polluting effect of nitrogen oxides.

.....  
.....  
.....  
..... [3]

A new type of paint is being developed. When applied to pavements and walls, it reduces the polluting effects of nitrogen oxides.

The new paint consists of a porous polymer which contains small particles of calcium carbonate and a catalyst, titanium dioxide (see Fig. 2.1).



Fig. 2.1

When nitrogen oxides attach to the titanium dioxide particles, reactions occur which convert these nitrogen oxides into nitric acid.

(b) Explain why the polymer must be porous.

..... [1]

- (c) (i) The equation below shows one of the possible reactions which occur on the titanium dioxide. Balance this equation.



- (ii) The nitric acid has a low pH value. Give the formula of the ion present in nitric acid responsible for this low pH value.

..... [1]

- (iii) What will happen to the acid when it comes into contact with the calcium carbonate in the paint?

..... [1]

- (d) Explain why it is an advantage for both the titanium oxide and the calcium carbonate to be in a very finely divided form.

.....  
 .....  
 ..... [2]

- (e) Is the use of this paint likely to be an effective solution to the problems caused by nitrogen oxides? Justify your answer.

.....  
 .....  
 ..... [2]

- (f) State **one other** way in which calcium carbonate has been used to reduce the effects of pollution.

.....  
 ..... [1]

[Total: 16]

- 3 In August 2003, the North American power grid failed, cutting electrical power to over 50 million people.

The blackout was caused by a series of events which resulted in the current in some parts of the grid increasing to very high levels.

The blackout began when a 375 kV power line, transmitting 200 MW of power, failed.

- (a) Why is electrical power transmitted at very high voltages, such as 375 kV?

..... [1]

- (b) (i) State the equation which shows the relationship between power, voltage and current.

..... [1]

- (ii) Express 200 MW and 375 kV in terms of watts and volts.

200 MW = ..... W

375 kV = ..... V [1]

- (iii) Use your answers to (b)(i) and (ii) to calculate the current in a 375 kV power line which is transmitting 200 MW.

current = ..... amps [2]

- (c) The failure of this power line caused some other power lines in the grid to overheat. Explain why this happened.

.....  
 .....  
 ..... [2]

- (d) Power companies in the United States try to buy their electricity from the cheapest sources. This often means purchasing from power stations thousands of miles away, for example in Mexico. State **one** disadvantage of transmitting electricity over long distances.

..... [1]

[Total: 8]

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- 4 Poly(ethene) is a material with a range of uses. The properties of poly(ethene) depend on the method of manufacture. This question is about two methods for manufacturing poly(ethene).

- (a) Fig. 4.1 shows how ethene molecules join together to form part of a poly(ethene) chain.

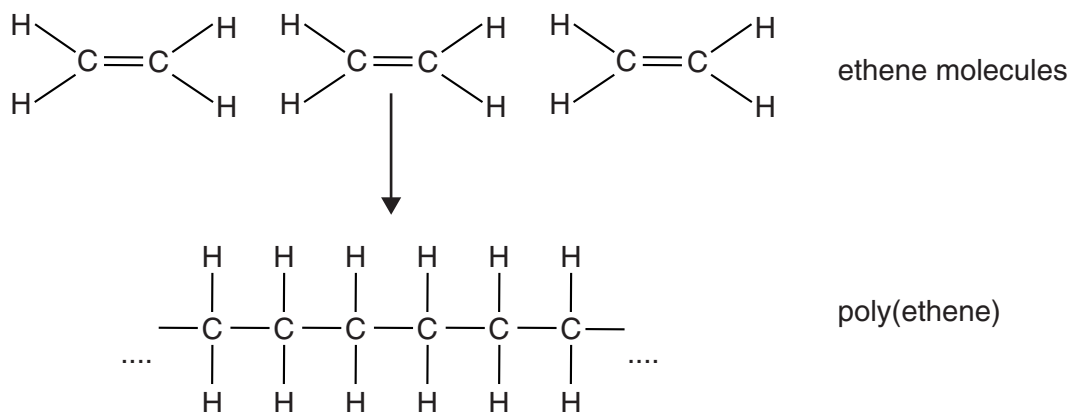
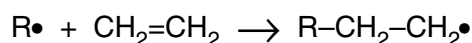


Fig. 4.1

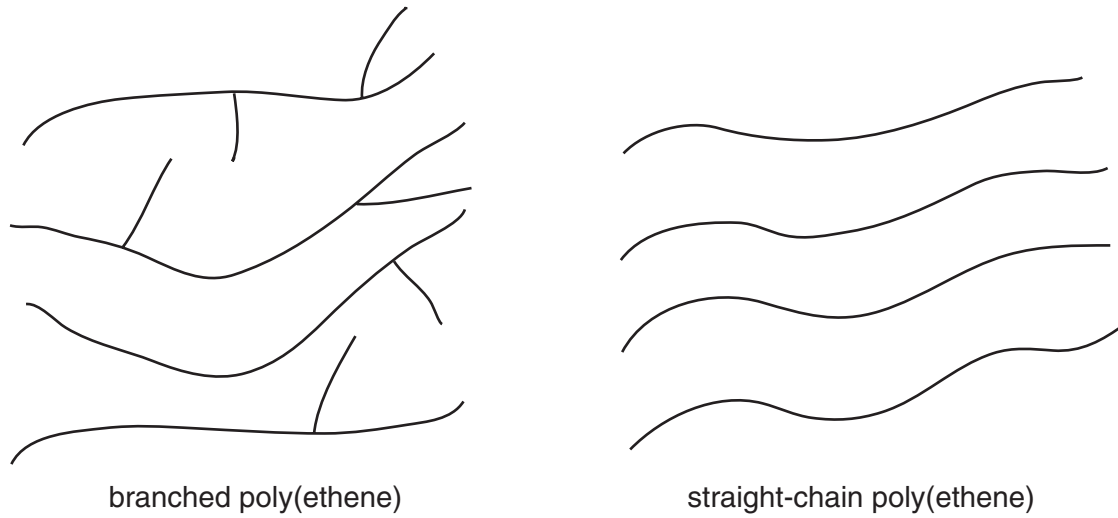
- (i) Explain how you can tell from the diagram that the polymerisation of ethene is an addition process.
- ..... [1]
- (ii) What is the meaning of the double lines between the C atoms in the ethene molecules?
- ..... [1]
- (b) In one method for production of poly(ethene), an initiator is used to start the reaction. This is shown in the equation below ( $R\bullet$  represents the initiator).



- (i) This equation involves radicals. Explain what is meant by the term *radical*.
- ..... [1]
- (ii) Draw a circle round each of the two radicals in this equation. [1]
- (iii) Suggest why the reaction occurs much more quickly in the presence of an initiator.
- .....
- ..... [2]



- (c) The method described in (b) produces branched poly(ethene) molecules. A second method produces straight chain poly(ethene) molecules. Fig. 4.2 shows how branched and straight-chain molecules are arranged in the solid polymers.



**Fig. 4.2**

- (i) Use Fig. 4.2 to explain why branched poly(ethene) has a lower density than straight-chain poly(ethene).

.....  
 .....  
 ..... [2]

- (ii) Suggest another property which is likely to be different for these two types of poly(ethene).

..... [1]

[Total: 9]

- 5 Chemical processes, such as the production of poly(ethene), are carried out in such a way as to make the process as economical as possible while also minimising the environmental burden.

Features of the process which need to be considered in order to do this include

- the presence of catalysts
- choice of solvent
- temperature
- pressure
- the methods of disposal of any residues.

- (a) A catalyst is used in the production of high-density poly(ethene) in order to increase the rate of reaction between ethene molecules.

Use ideas about collisions between molecules to explain why the use of a catalyst increases the rate of a reaction.

.....

.....

.....

.....

.....

.....

..... [4]

- (b) In this question, two marks are available for the quality of written communication.

Fig. 5.1 gives some data about two methods used to produce poly(ethene). Different types of poly(ethene) are produced depending on the method used.

<b>type of poly(ethene) produced</b>	<b>low-density</b>	<b>high-density</b>
<b>substances added to ethene</b>	peroxide initiator	titanium chloride catalyst and hexane solvent
<b>pressure used</b>	1500 atmospheres	30 atmospheres
<b>temperature used</b>	300 °C	80 °C
<b>other comments</b>		solvent recycled and re-used

**Fig. 5.1**

Describe how the method used to produce high-density poly(ethene) has a lower environmental burden than the method used to produce low-density poly(ethene).

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

Quality of Written Communication [2]

[Total: 10]

- 6 The manufacture of paper generates large quantities of waste. One substance present in the waste is xylose, a type of sugar.

New research suggests that this waste xylose could be used as a source of electrical energy.

- (a) Paper contains starch and cellulose.

State the role of these substances in **plants**.

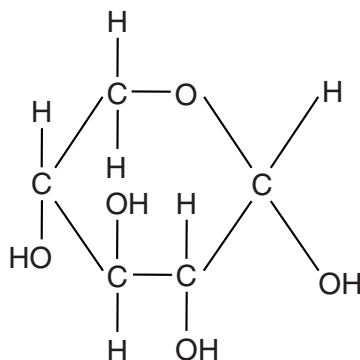
starch

.....

cellulose

..... [2]

- (b) A molecule of xylose has the structure shown in Fig. 6.1.



**Fig. 6.1**

Sugars are carbohydrates. They have the general formula  $C_x(H_2O)_y$ .

What are the values of x and y in the formula of xylose?

x = ..... y = ..... [1]

- (c) The method suggested for generating energy from xylose involves bacteria which convert xylose into carbon dioxide and water.

- (i) What name is given to the process in living cells in which sugars are converted into carbon dioxide and water?

..... [2]

- (ii) The action of bacteria on xylose can be used to produce an electrical current in a piece of equipment known as a fuel cell.

State the energy transfer which occurs during the breakdown of xylose in this way.

from ..... to ..... [1]

- (d) Other bacteria break down glucose but are unable to break down xylose. This is because the enzymes in bacteria are specific to one type of substrate. Explain why enzymes are specific in this way.

.....  
.....  
.....  
..... [3]

[Total: 9]

**END OF QUESTION PAPER**





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