

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

SCIENCE

2842

Science and Human Activity

Friday

10 JUNE 2005

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	9	
2	15	
3	15	
4	8	
5	13	
TOTAL	60	

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

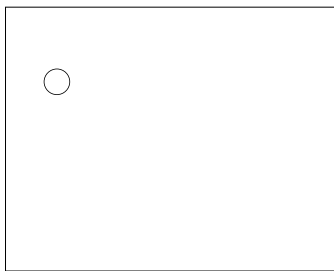
Answer **all** the questions.

1 The 'hydrogen car', which uses hydrogen as a fuel, is widely regarded as being the car of the future. It is claimed that driving a hydrogen car will produce no pollutants. However, there are practical problems with storing the hydrogen fuel.

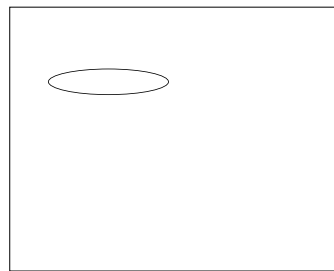
(a) At room temperature, hydrogen is a gas whereas conventional fuels, such as petrol, are liquids.

Complete the following diagrams to show how molecules of hydrogen and petrol are arranged.

○ represents a hydrogen molecule and  represents a petrol molecule.



hydrogen



petrol

[2]

(b) (i) Explain how a gas, such as hydrogen, exerts a pressure on the walls of a container, such as a fuel tank.

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

(ii) Hydrogen gas must be compressed if the fuel tank of a car is to carry enough hydrogen.

Normal atmospheric pressure is approximately 1×10^5 Pa. What pressure would be required to decrease the volume of hydrogen fuel from 200 m^3 to 0.5 m^3 ? Assume that the temperature remains constant.

answer Pa [2]

(c) When hydrogen is oxidised to water, H_2O , energy is released. This is the reaction that powers a hydrogen car.

(i) Why is this reaction described as oxidation?

..... [1]

(ii) Name **one** product, other than water, formed when **hydrocarbon** molecules in petrol are oxidised.

..... [1]

(iii) State **one** environmental problem that results from the release of this product.

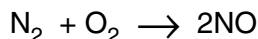
..... [1]

[Total: 9]

- 2 Nitrogen oxides, NO_x , are substances that cause pollution problems, especially in large cities where there is a great deal of car use.

- (a) Nitrogen monoxide, NO , is formed from nitrogen and oxygen reacting in car engines.

The equation for this process is



- (i) State **two** conditions necessary for this reaction to occur rapidly in a car engine.

1

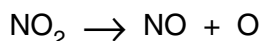
2 [2]

- (ii) The nitrogen monoxide emitted from the engine then reacts with oxygen from the air to produce nitrogen dioxide, NO_2 . Write down a balanced chemical equation for this process.

..... [2]

- (b) One of the pollution problems caused by nitrogen dioxide is that it can create ground level ozone.

The first step in this process is the breakdown of nitrogen dioxide, as shown in the equation below:



- (i) Suggest a second step which would lead to the formation of ozone, O_3 .

..... [1]

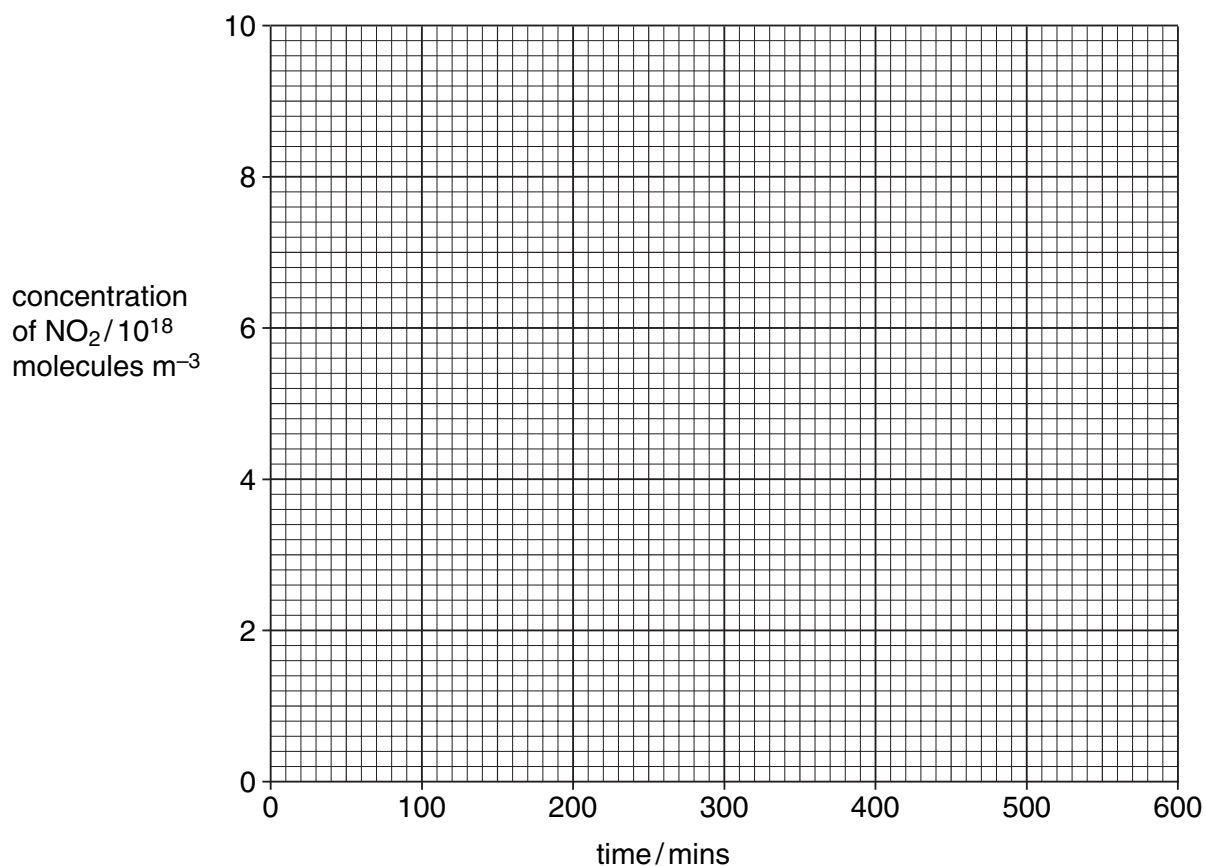
- (ii) Experiments have been done to find out how rapidly NO_2 breaks down in a variety of conditions.

The results of one experiment are given in Fig. 2.1.

concentration of $\text{NO}_2 / 10^{18} \text{ molecules m}^{-3}$	time / mins
9.6	0
5.4	100
3.6	200
2.2	300
1.6	400
1.1	500
0.8	600

Fig. 2.1

Plot these data on the graph opposite and draw a smooth curve to show the pattern in the data. [2]



- (iii) Use the graph to calculate a value for the time taken for the NO_2 concentration to fall to one half of its original value.

answer mins [1]

- (iv) The decomposition of nitrogen dioxide is thought to be a first order reaction. Explain how you would use the graph to confirm this.

.....

..... [2]

- (v) Write a rate equation to describe how rate depends on NO_2 concentration in this reaction, assuming it is first order.

..... [2]

(c) The decomposition of nitrogen dioxide is the slowest step in the series of chemical reactions which eventually produces ozone.

(i) What name is given to the slowest step in a series of chemical reactions?

..... [1]

(ii) The decomposition of nitrogen dioxide is **very** slow at night. Suggest a reason for this.

..... [1]

(d) Ozone is not normally present in the lowest level of the atmosphere. Name the part of the atmosphere in which ozone is normally found.

..... [1]

[Total: 15]

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- 3 Thunderstorms are common weather events in many parts of the world. The thunder and lightning observed during these storms can be explained by using ideas about electrical charge and the fields that these charges produce.

(a) The field lines associated with a thundercloud are shown in Fig. 3.1.

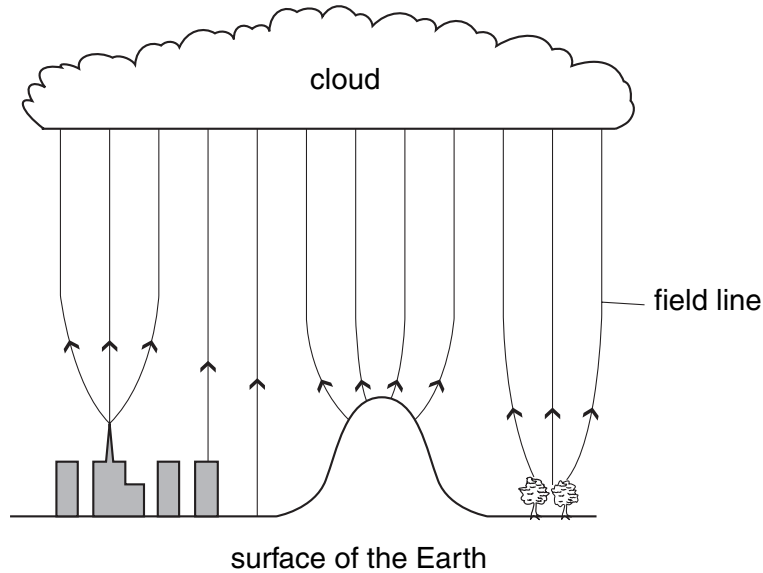


Fig. 3.1

- (i) The cloud and the Earth's surface both have electrical charge. What do the directions shown on the field lines tell you about the sign of the charge on the underside of the cloud? Explain your reasoning.

.....

 [2]

- (ii) Air is normally described as an insulator. State the meaning of the term *insulator*.

..... [1]

- (iii) If the strength of the field is high enough, the molecules of air become ionised. Explain what happens when a molecule becomes ionised.

.....
 [2]

- (iv) What would happen to the strength of the field if the charge on the cloud increased?

..... [1]

(b) The force on a charged object placed in an electrical field is given by the equation:

$$\text{force} = \text{charge} \times \text{electrical field strength}$$

Use this equation to calculate the electrical field strength if a charge of $2 \times 10^{-5} \text{C}$ experiences a force of 3 N. Show your working.

answer NC^{-1} [2]

(c) When air is ionised, a current can flow between the ground and the cloud. As the current flows, light and heat are generated. This is known as lightning.

(i) Lightning often strikes objects such as trees, steeples and hill-tops because the field strength is greater close to these objects. Explain how Fig. 3.1 shows that the field is stronger close to these objects.

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

(ii) Write down the relationship between power, voltage and current.

..... [1]

(iii) Use this relationship to calculate the power of a lightning bolt in which a current of 2 A flows across a voltage of $1.5 \times 10^8 \text{V}$. Show your working and remember to state the units in your answer.

answer units [2]

(d) Some people believe that exposure to the electric fields from power lines is harmful to human health.

Exposure to the fields beneath thunderclouds is not thought to be harmful, even though the fields are much stronger.

Explain why these fields are not likely to be harmful to human health, whereas those from power lines may be.

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

[Total: 15]

- 4 This question is about the development of new 'greener' packaging materials.

Fragile objects are often packaged in foam. In the past, the foam has been made from substances such as poly(propene) but it is now often made from starch.

- (a) Poly(propene) is a polymer, made from many propene molecules joined together.

The structure of propene is shown in Fig. 4.1

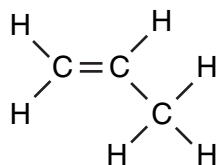


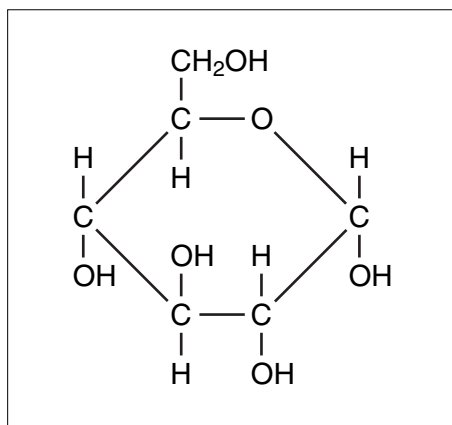
Fig. 4.1

What structural feature, present in propene, allows it to form polymers?

..... [1]

- (b) Starch is a naturally-occurring polysaccharide, built up from many glucose molecules joined together.

The structure of glucose is shown below:



- (i) Use this diagram to deduce the chemical formula of a molecule of glucose.

answer [1]

(ii) Starch and glucose are both described as carbohydrates. State the meaning of the term *carbohydrate*.

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

(c) One reason why starch-based packaging materials are being used in increasing amounts is because the production and disposal of starch places less of a burden on the environment than the production and disposal of poly(propene).

(i) Describe how the **production** of starch results in a lower environmental burden than the production of poly(propene).

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

(ii) Suggest why the **disposal** of starch-based packaging may also result in a lower environmental burden than the disposal of poly(propene).

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

[Total: 8]

- 5 Enzymes are proteins that are essential to all cellular functions.

A ribbon diagram of an enzyme is shown in Fig. 5.1.



Fig. 5.1

- (a) What features of the structure are shown by labels A, B and C?

A

B

C [3]

Enzyme structure can also be shown by space-filling diagrams. A space-filling diagram of the same enzyme is shown in Fig. 5.2.

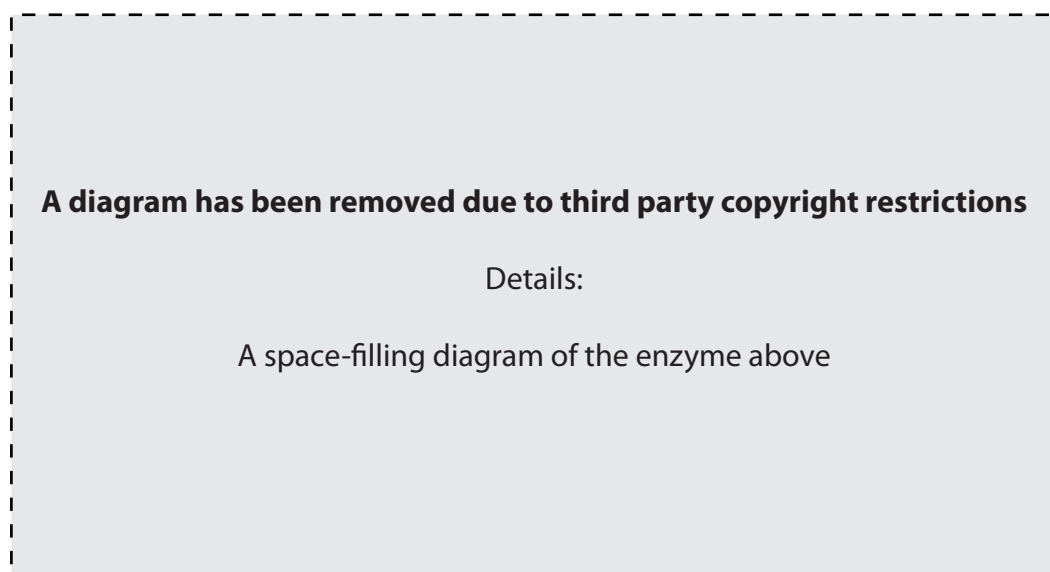


Fig. 5.2

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