

**ADVANCED GCE
SCIENCE**

Science and Environmental Management

FRIDAY 13 JUNE 2008

2844

Afternoon
Time: 1 hour 30 minutes

Candidates answer on the question paper
Additional materials (enclosed): None

Additional materials (required):
Electronic calculator
Ruler



Candidate Forename

Candidate Surname

Centre Number

Candidate Number

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **90**.
- 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	13	
2	14	
3	9	
4	12	
5	11	
6	13	
7	18	
TOTAL	90	

This document consists of **16** printed pages.

Answer **all** the questions.

- 1 (a) The disease malaria is described by the World Health Organisation as a disease of poverty and a cause of poverty. It is estimated that one African child dies from malaria every thirty seconds.

The common garden plant Sweet Wormwood (*Artemisia annua*) is the source of the anti-malarial drug artemisinin. Sweet Wormwood is now grown as a crop in African countries such as Kenya and Tanzania.

- The annual yield of dry leaf per hectare varies from 1000 kg to 4600 kg
- Dry leaf contains 1% artemisinin
- 50% of this can be extracted.

- (i) Suggest **two** reasons why the annual yield of dry leaf per hectare can vary from year to year.

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..... [2]

- (ii) From the above figures calculate the **maximum** mass of artemisinin which can be extracted from one hectare.

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maximum mass extracted per year kg ha⁻¹ [2]

- (b) In a trial the average mass of artemisinin produced from one hectare was 20 kg per year. The worldwide demand for artemisinin is estimated at 400 tonnes per year. (1 tonne = 1000 kg.)

How many hectares would need to be planted to provide 400 tonnes of artemisinin per year?

Answer = hectares [2]

(c) Plant breeders at the University of York are trying to develop a non-GM strain (using **artificial selection**) of Sweet Wormwood, which could be planted in sub-Saharan Africa to limit the amount of land needed to produce this drug.

(i) Explain how artificial selection would be carried out to develop this strain.

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..... [3]

(ii) Genetic modification is another way to develop a better strain of Sweet Wormwood. State **two** advantages and **two** disadvantages to using genetic modification in this way.

advantages

.....
.....
.....

disadvantages

.....
.....
..... [4]

[Total: 13]

- 2 North Africa and the Middle East hold more than 6% of the global population, but less than 2% of the world's renewable fresh water. This means that such countries need to use desalination plants to provide fresh water from seawater.

Until recently, most of these countries used distillation to provide drinking water. Simple distillation is a very energy-consuming process. This can be improved upon by multi-stage flash distillation (MSF). A diagram of a MSF plant is shown in Fig. 2.1.

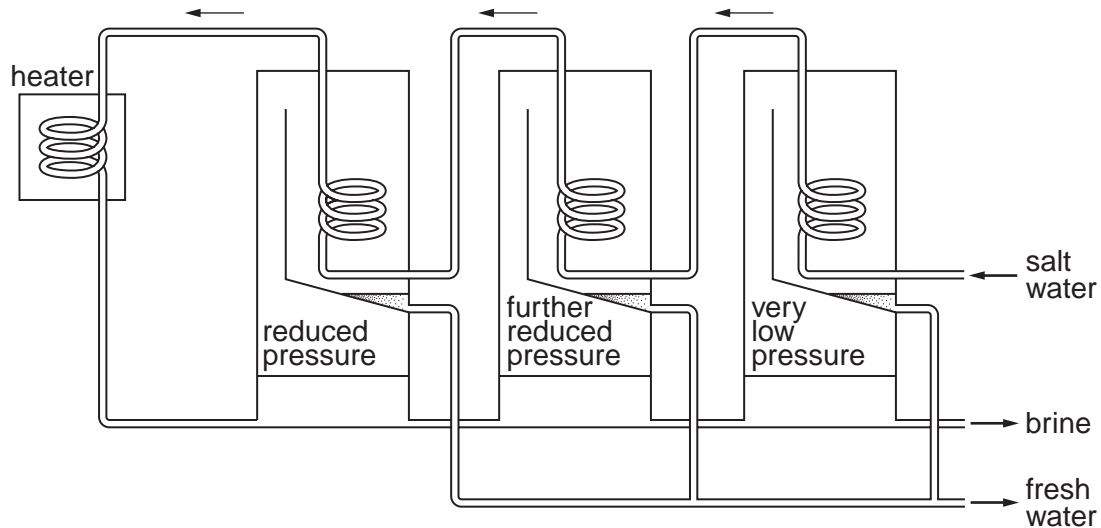


Fig. 2.1

In the MSF process, sea water is heated and passes into a series of vessels called stages. The water boils rapidly in these vessels and the water vapour is then condensed to form pure water.

- (a) The evaporation of water is a reversible process, as shown in equation 2.1.



- (i) The direction of change in a reversible process, such as equation 2.1, can be predicted using Le Chatelier's Principle.

State *Le Chatelier's Principle*.

.....

.....

.....

.....[2]

(ii) Use Le Chatelier's Principle and equation 2.1 to explain why lowering the pressure encourages the formation of water vapour.

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

(iii) The change from steam to water is exothermic. What is meant by the term *exothermic*?

.....[1]

(iv) Describe one other feature of the MSF process (apart from reducing the pressure) which reduces the energy requirement of the plant.

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

(c) Suggest why desalination using MSF or reverse osmosis is not used to provide water for irrigation of agricultural land.

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

(d) Sea water contains sodium ions and chloride ions. Name **two other** ions present in relatively high concentrations in sea water.

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

[Total: 14]

3 Entropy is a measure of disorder of particles in a system.

- (a) The entropy in a system can increase, decrease or stay the same when different processes occur.

Complete the following table to predict the entropy change in the system when the following processes occur.

process	entropy change
A solid melts to form a liquid	
A gas is cooled	decreases
A solution is diluted by adding water	

[2]

- (b) (i) Use ideas about particles to explain why the entropy of the system decreases when a gas condenses to form a liquid.

.....

 [2]

- (ii) Entropy changes can also occur in the surroundings if the system exchanges energy with the surroundings.

Explain why the entropy of the surroundings increases when a gas condenses to form a liquid.

.....

 [2]

- (iii) The second law of thermodynamics states that for any change the **overall** entropy must increase. Explain how the process of a gas condensing to a liquid satisfies this law.

.....

 [3]

[Total: 9]

4 Eutrophication is a natural process that can happen to lakes over long periods of time. Slow changes in the lake ecosystem can be caused as a result of eutrophication.

(a) Describe how this natural eutrophication could occur and suggest some ways in which the ecosystem will change as a result.

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.....[5]

(b) The rate of eutrophication is affected by several factors including the temperature of the water in the lake and the rate at which certain substances are input into the lake.

(i) What name is given to factors, such as temperature, which do not result from the activity of other organisms?

.....[1]

(ii) State one other factor that might affect the rate of eutrophication of a lake, which is also not a result of the activity of other organisms.

.....[1]

(iii) Describe how human activity may cause rapid eutrophication of lakes.

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

(c) Sources of pollution, such as those causing changes to river or lake ecosystems, are often categorised as point sources or diffuse sources.

(i) State an example of a point source of pollution for a river or lake.

.....[1]

(ii) State the meaning of the word **diffuse** in this context.

.....[1]

(iii) State an example of a diffuse source of pollution for a river or lake.

.....[1]

[Total: 12]

- 5 (a) Below is a passage about plant reproduction. It contains blank spaces. Fill in the blank spaces with words from the box.

Each term may be used once, more than once or not at all.

asexual	cross-over	diploid	four
gamete	haploid	heterozygous	homologous
independent assortment	meiosis	mitosis	sexual
two	zygote		

Variation occurs in plants when they undergo reproduction.

Each parent plant contributes one These fuse to produce a

Production of these cells happens by a process known as

At the first stage in this process the chromosomes align in the middle of the cell to form pairs. The pairs then separate to opposite ends of the cell in a process described as

The cell membrane pinches inwards and the cell then divides to form two cells, which divide again by a process similar to mitosis. This produces a total of daughter cells. Each of these cells contains one copy of each type of chromosome. These are therefore known as cells. [8]

- (b) Plant breeders also make use of asexual reproduction in producing plants, often using artificial techniques which do not occur naturally.

(i) Name one artificial technique used by plant breeders to produce plants by asexual reproduction.[1]

(ii) Describe the advantages of using asexual reproduction in a plant breeding programme.[2]

[Total: 11]

[Turn over

6 Gas-liquid chromatography (g.l.c.) is used for the detection and analysis of organic compounds found as pollutants in water. The mixture of compounds in the water is separated by a partition between the mobile phase and the stationary phase in the g.l.c. column. The presence of different substances is shown by the different peaks on the chart recorder trace.

Fig. 6.1 is a diagram of the apparatus used for g.l.c.

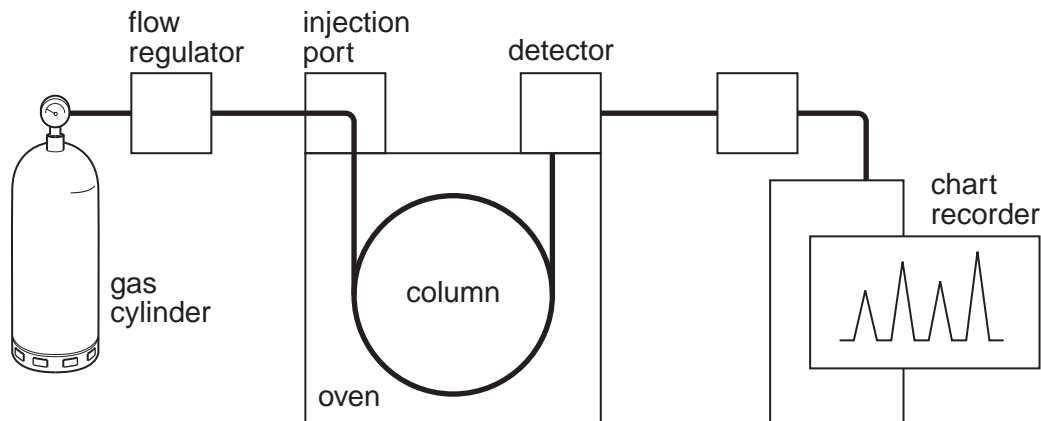


Fig. 6.1

(a) Explain what is meant by

(i) the *mobile phase*

.....

(ii) the *stationary phase*.

.....

[2]

(b) (i) Give an example of a suitable carrier gas.

.....[1]

(ii) What is the purpose of the oven in which the column is placed?

.....[1]

(iii) Explain why different compounds in the sample will appear as different peaks on the chart recorder.

.....

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.....[3]

(c) Fig. 6.2 is a g.l.c. trace showing the organic pollutants detected in a sample of water.

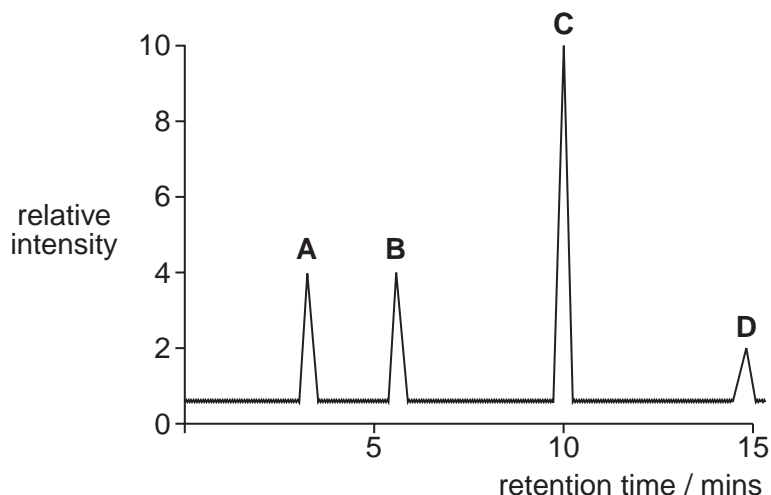


Fig. 6.2

(i) Compound **C** has a retention time of 10 minutes. State the meaning of the term **retention time**.

.....[1]

(ii) Use the information in the g.l.c. trace to estimate the percentage each compound contributes to the organic pollutants in the water sample, showing clearly how you used the information in the trace.

A..... % **B**.....% **C**.....% **D**.....% [2]

(iii) The sample of water was known to contain significant amounts of **five** impurities. Suggest a reason why only four peaks are seen in the g.l.c. trace.

.....
[1]

(d) Name two other techniques, apart from chromatography, which could be used to analyse a water sample to show the presence of pollutants.

1.
 2.[2]

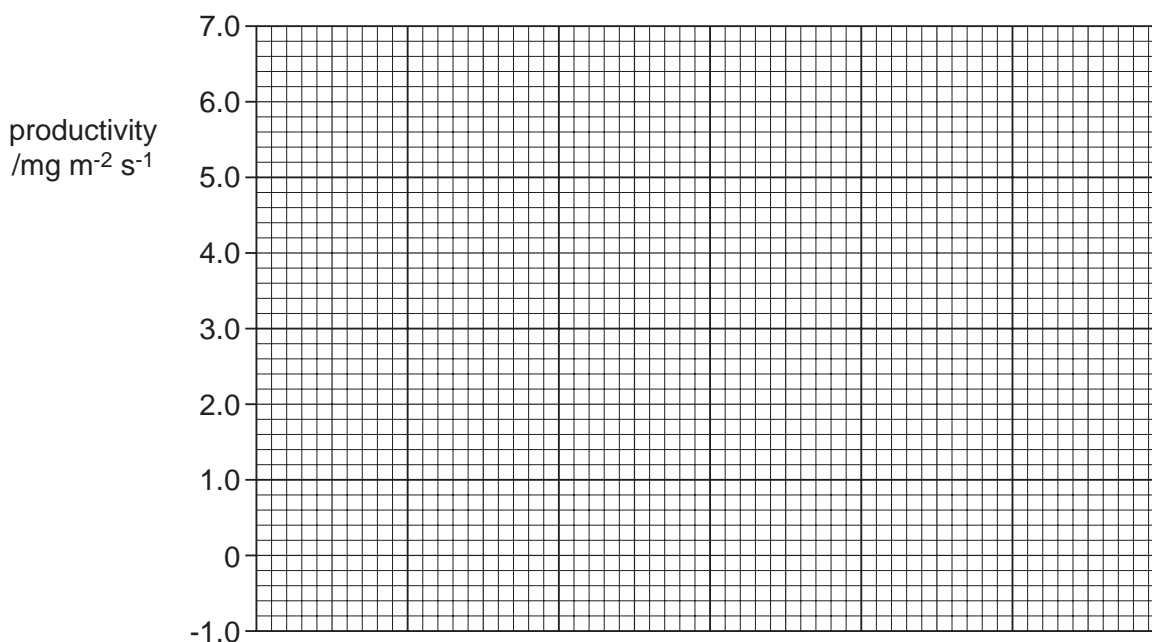
[Total: 13]

7 The concentration of carbon dioxide, CO₂, in the atmosphere is currently around 380ppm (parts per million). However it is rising rapidly and scientists predict that it may rise to between 400 and 500ppm by the end of the century. This rise is likely to produce an increase in global temperature of between 2°C and 5°C. This may cause dramatic effects on, for example, the growth and productivity of plants.

(a) Some scientists claim that the increase in CO₂ concentration may produce an increase in productivity (the rate at which biomass is stored) of plants. They claim that this increase in productivity may help to counteract the increase in CO₂ concentration.

Laboratory studies have been done to investigate this effect. Results from one study are shown in the table below.

CO ₂ concentration / ppm	Productivity / mg m ⁻² s ⁻¹
0	-0.9
200	1.1
400	2.3
600	3.1
800	3.7
1000	4.0
1200	4.1



(i) Plot a graph of these data. Label the x-axis appropriately and use a smooth curve to show the pattern in the data. [3]

(ii) Suggest how a plant can have a **negative** value of productivity.
[1]

(iii) Do the results suggest that the likely rise in CO₂ in the next century will increase the productivity of plants? Explain your answer.

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

(iv) Explain why a rise in productivity could help to counteract increasing CO₂ concentrations.

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

TURN OVER FOR QUESTION 7(b)

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

The higher **temperatures** expected by the end of the century will, however, cause significant problems for many plants. One of the reasons for this is that the efficiency of photosynthesis will be reduced by a process called *photorespiration*.

Some plants are adapted to conditions of high temperature by carrying out photosynthesis by the C4 pathway. This reduces photorespiration.

Explain the principles behind this adaptation. In your answer you should:

- explain what is meant by photorespiration and why it affects the efficiency of photosynthesis
- describe the C4 pathway
- explain how this helps to reduce the problems of photorespiration.

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Quality of Written Communication [4]

[Total: 18]

END OF QUESTION PAPER

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