

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

SCIENCE

2844

Science and Environmental Management

Thursday **26 JANUARY 2006** Morning 1 hour 30 minutes

Candidates answer on the question paper.

Additional materials:
Electronic calculator

Candidate Name	Centre Number	Candidate Number												
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TIME 1 hour 30 minutes

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 and 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	15	
2	13	
3	15	
4	17	
5	20	
6	10	
TOTAL	90	

This question paper consists of 16 printed pages.

Answer **all** the questions.

- 1 Most cells reproduce by the process of mitosis. In sexual reproduction, male and female gametes are formed by the process of meiosis. Fig. 1.1 is a diagram illustrating the processes of mitosis and meiosis in cells with one pair of homologous chromosomes.

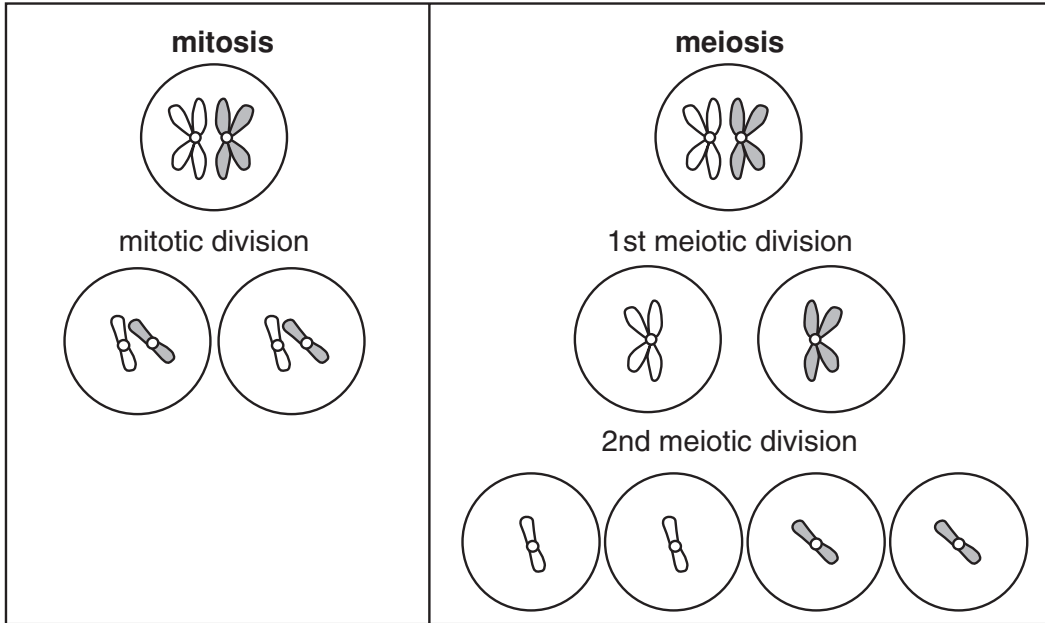


Fig. 1.1

- (a) (i) Use letters **A** to **D** to label on the diagram:

- A** a diploid cell
- B** a haploid cell
- C** a pair of chromatids
- D** a pair of homologous chromosomes.

[4]

- (ii) On the diagram, draw a circle around **two** genetically identical cells.

[1]

- (b) The processes that occur during meiosis lead to genetic variation. Explain how the following two processes contribute to this variation.

- (i) independent assortment of homologous chromosomes

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[2]

- (ii) crossing over

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[2]

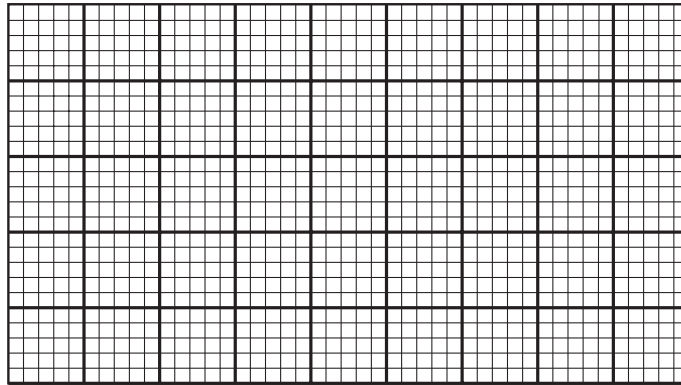
- (c) Leaves were collected from a species of plant growing in a woodland area. Fig. 1.2 shows the lengths of the leaves in the sample.

length of leaf / mm

31	37	33	33	34	35	39	36	38	35
34	35	34	35	36	35	32	36	37	

Fig. 1.2

- (i) On the grid below, draw a histogram to show the distribution of leaf length in the sample of plant leaves.



[3]

- (ii) What kind of distribution is shown in the graph?

.....[1]

- (iii) What is the **median** length of leaf in this sample?

..... [1]

- (iv) A similar study in a different part of the wood showed that the leaves of the same species of plant had a similar distribution, but the median length was shorter. Suggest **one** explanation for this.

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

[Total: 15]

- 2 Some species of ladybird vary in their appearance. This variation is genetically controlled. Fig.2.1 shows two varieties of a species of ladybird. Both the varieties have two spots, but one variety has black wing cases, and the other has red wing cases. This variation is controlled by a single pair of genes. The allele for black wing cases is dominant to that of red wing cases.

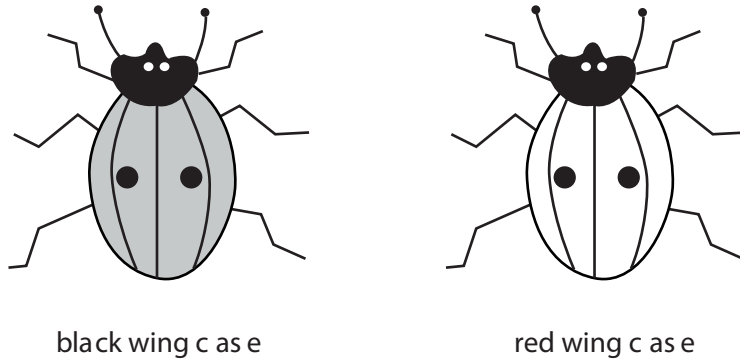


Fig.2.1

- (a) State the meaning of the term allele.

.....[1]

- (b) (i) Draw a diagram to show the genotypes of the offspring you would expect from a cross between a ladybird with a red wing case, and a ladybird heterozygous for the wing case alleles. Use B for the dominant allele, and b for the recessive allele.

[3]

- (ii) What percentage of the ladybirds from the above cross would you expect to have red wing cases?

.....% [1]

- (c) Ladybirds are often welcome in the garden, as they do not eat plants, but they eat some of the pests that can damage plants. Another method of pest control is spraying plants with insecticide.

Explain how spraying plants with insecticide can harm ladybirds even if they do not come into direct contact with the insecticide.

.....

[2]

(d) Genetic modification can produce plants that make their own insecticides. *Bacillus thuringiensis* is a naturally occurring bacterium that produces a protein that is lethal to insect larvae. A gene for this protein has been transferred into corn plants. Once the gene is in a corn plant, the plant can produce the insecticide by protein synthesis.

(i) Explain how protein synthesis in a cell produces the protein from the transferred gene.

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.....[4]

(ii) Describe **one** possible disadvantage of the practice of inserting 'foreign' genes into plants.

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.....[2]

[Total: 13]

3 To produce a good harvest of crops, farmers must often add synthetic fertiliser to soils. The use of synthetic fertilisers allows crops to be grown in soils where the nutrients have become depleted, for example by leaching out of the soil.

(a) Name **two elements** which plants need from the soil in order to grow successfully.

1

2[2]

(b) How else, other than by leaching, might nutrients become depleted?

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.....[1]

(c) Too much synthetic fertiliser applied to the soil can cause environmental problems, as the excess fertiliser in the soil can leach into waterways. This can eventually result in the death of fish.

Explain why fish may die.

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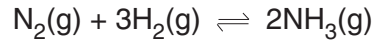
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.....[4]

- (d) Ammonia is widely used in the manufacture of synthetic fertiliser. Ammonia is produced from nitrogen and hydrogen gas. The equation for this reaction is given below.



- (i) This reaction is reversible.
How does this affect the amount of ammonia that can be produced by the reaction?

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.....[2]

- (ii) The reaction producing ammonia is exothermic. The resulting increase in temperature reduces the amount of ammonia produced by the reaction. Explain why.

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.....[3]

- (iii) Increasing the pressure increases the amount of ammonia produced by the reaction. Explain why.

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.....[3]

[Total: 15]

- 4 There are many kinds of chemicals that can cause water pollution. Pollution of waterways can be detected by analysing samples of water. One way to do this is by visible spectroscopy. Fig. 4.1 shows the visible spectrum of Cu^{2+} ions in aqueous solution.

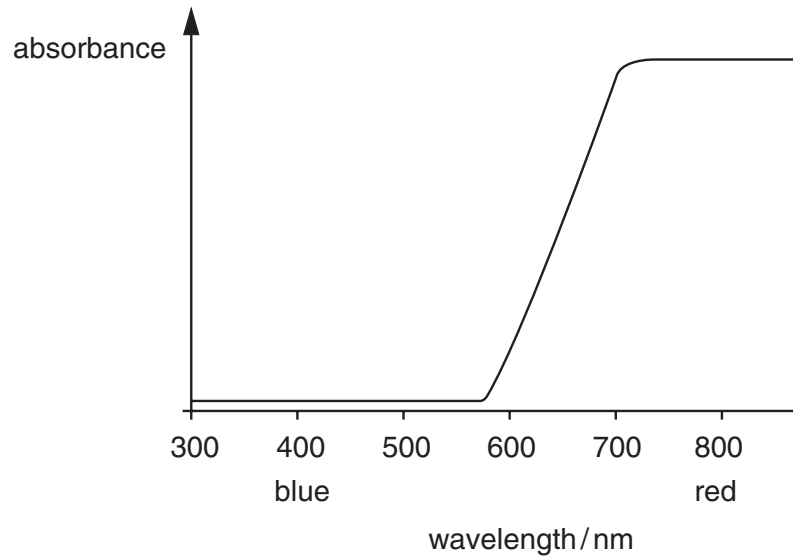


Fig. 4.1

- (a) Explain, using Fig. 4.1, the colour of Cu^{2+} ions in aqueous solution.

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.....[2]

- (b) The concentration of Cu^{2+} ions in aqueous solution can be measured using a colorimeter. Fig. 4.2 is a diagram to show how a colorimeter works.

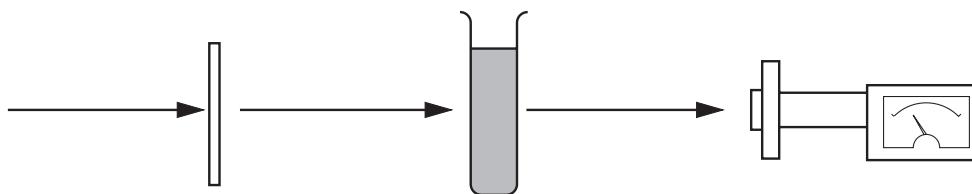


Fig. 4.2

- (i) Use letters **A–E** to label on the diagram:

- A** detector
B filter
C incident light beam
D sample
E transmitted light.

[3]

- (ii) Explain the function of the filter.

.....
[2]

- (iii) Describe how the colorimeter is used to measure the concentration of Cu^{2+} ions in a sample of water.

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[4]

(c) State **two** strategies that should be adopted when sampling water from a river or stream, to ensure that the results are representative of the true amount of pollution in the stream.

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.....[2]

(d) Another way of analysing water for pollutants is to use infrared spectroscopy. Infrared spectroscopy involves passing a beam of infrared radiation through a sample.

Explain, in terms of the interaction of molecules and atoms with electromagnetic radiation, how infrared and visible spectroscopies are different.

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.....[4]

[Total: 17]

5 In order to grow successfully, plants need light energy. Complete the word equation below, which summarises the process of photosynthesis.

(a) + carbon dioxide $\xrightarrow{\text{light energy}}$ oxygen + [2]

(b) Only the first stage of photosynthesis is light-dependent. The rest of the process of photosynthesis does not require light (light-independent).

(i) Describe what takes place in the **light-dependent** stage of photosynthesis.

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.....[3]

(ii) In most green plants, the light-independent stage of photosynthesis follows the C3 pathway. Describe what takes place in the **light-independent** stage of photosynthesis in C3 plants.

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.....[3]

(c) Explain why **photorespiration** occurs in areas where temperature and light intensity are high.

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.....[2]

6 In this question, four marks are available for the quality of written communication.

In dry countries, obtaining enough water for drinking may be a problem. Drinking water may be obtained from salt water by the process of reverse osmosis.

Fig. 6.1 shows a solution of pure water on one side of a semi-permeable membrane, and salt water on the other.

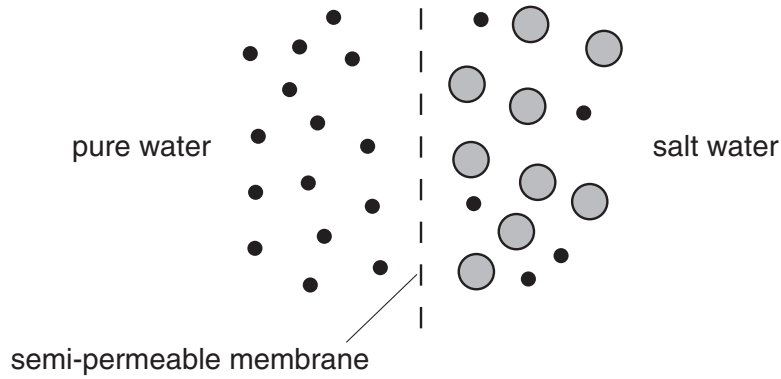


Fig. 6.1

Describe the passage of molecules across the membrane by osmosis, and explain how the system can be modified to carry out reverse osmosis to obtain drinking water.

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.....[6]

Quality of Written Communication [4]

[Total: 10]

END OF QUESTION PAPER

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