

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

SCIENCE

2841

Science and the Natural Environment

Friday

9 JUNE 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	15	
2	19	
3	15	
4	11	
TOTAL	60	

This question paper consists of 12 printed pages.

Answer **all** the questions.

1 The most productive ecosystems on Earth are the 'tidal rain forests' that occur in certain estuaries. In the northern hemisphere, the major producers in these ecosystems are eelgrass (*Zostera*) and turtlegrass (*Thalassia*). These underwater plants form the basis of food webs in tidal rain forests.

(a) (i) What term is used to describe a level in a food web?

..... [1]

(ii) What term is used to describe **all** the organisms that depend on producers in a food web?

..... [1]

(b) Energy is transferred from producers through all the other organisms in a food web. Describe how this energy transfer occurs.

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

(c) The number of levels in a food web seldom exceeds five.

The quantity of useful energy diminishes at each transfer.

Most of the energy is transferred to a disordered form.

(i) Which scientific law states that the quantity of disordered energy increases as a result of an energy transfer?

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

(ii) What term is used to describe the disorder of energy?

..... [1]

(iii) What form does disordered energy take?

..... [1]

(d) An estuary is a semi-enclosed body of coastal water. A river flows into it and it is open to the sea. There is a continuous exchange of water between seawater and freshwater. One reason why estuaries have such high productivity is that there are high levels of nutrients.

(i) Explain what is meant by the term *productivity*.

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

(ii) State **one** factor that could cause productivity to differ between different estuary ecosystems.

..... [1]

(iii) Conditions in the different parts of an estuary vary with time.

Suggest why this variation occurs.

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

[Total: 15]

2 In October 1957, an accident at a nuclear power plant at Windscale released radioactive pollution over northern England. The accident occurred in a reactor being used to make the radioisotope, plutonium-239, starting from $^{235}_{92}\text{U}$, an isotope of uranium.

The reactor was also making polonium-210 from bismuth-210.

(a) Explain the meaning of the term *isotope*.

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

(b) $^{235}_{92}\text{U}$ is an isotope of uranium.

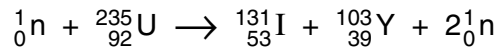
Which of the numbers, 235 or 92, is different in other isotopes of uranium?

What term is used to describe this number?

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

(c) The accident at Windscale caused nuclear fission reactions to occur.

One such reaction is described in the equation below.



Explain the meaning of the term *nuclear fission*.

Use this example in your explanation.

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

- (d) Fig. 2.1 shows estimates of the levels of radioactivity of some of the fission products released from the power plant in the Windscale accident. The level of radioactivity is measured in becquerel (Bq).

fission product	level of radioactivity / 10^{12} Bq
polonium-210	1370
iodine-131	800
tellurium-132	520
caesium-137 and others	40

Fig. 2.1

- (i) Using Fig. 2.2, sketch a bar chart to represent the information in Fig. 2.1.

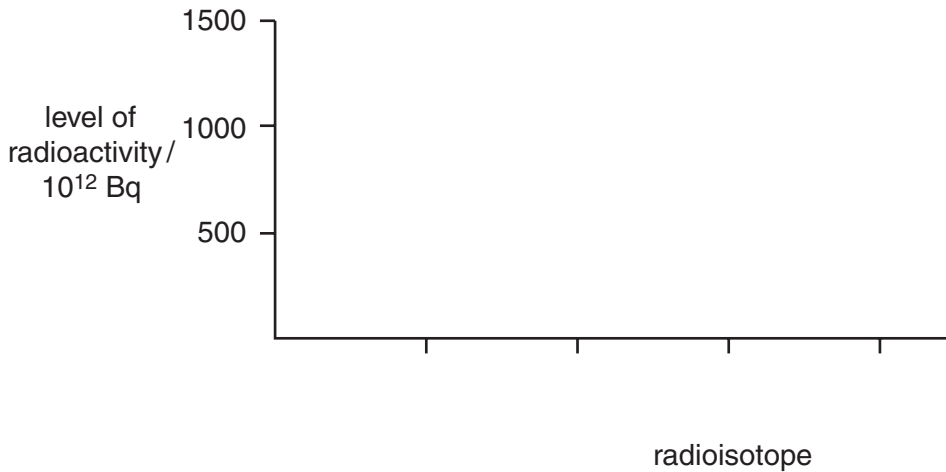


Fig. 2.2

[2]

- (ii) Calculate the percentage of the radioactivity that was released from the power plant in the form of iodine-131. Show your working.

percentage = % [2]

- (e) Substances containing fission products were released as a result of the Windscale accident.

Some of the substances, and their boiling points, are shown in Fig. 2.3.

Nuclear fission reactions also release large quantities of heat.

fission product	substance	boiling point / °C
iodine-131	I ₂	185
tellurium-132	TeO ₂	1245
caesium-137	CsI	1280

Fig. 2.3

Use the data in Fig.2.3 to suggest why iodine-131 was the most abundant fission product released.

.....

.....

..... [2]

- (f) There was particular concern about the release of iodine-131. In humans exposed to this radioisotope, iodine-131 becomes concentrated in the thyroid gland and can cause cancer of the thyroid. Milk supplies became contaminated with this radioisotope after the Windscale accident. Levels of radioactivity as high as 50 000 Bq per litre of milk were recorded.

Fig.2.4 shows how the level of radioactivity in a sample of milk, contaminated with iodine-131, changes with time.

time / days	level of radioactivity / Bq
0	50 000
3	39 000
6	30 000
9	23 000
12	18 000

Fig. 2.4

- (i) Plot the data from Fig. 2.4 on the grid in Fig. 2.5.
Draw a smooth curve through the points.

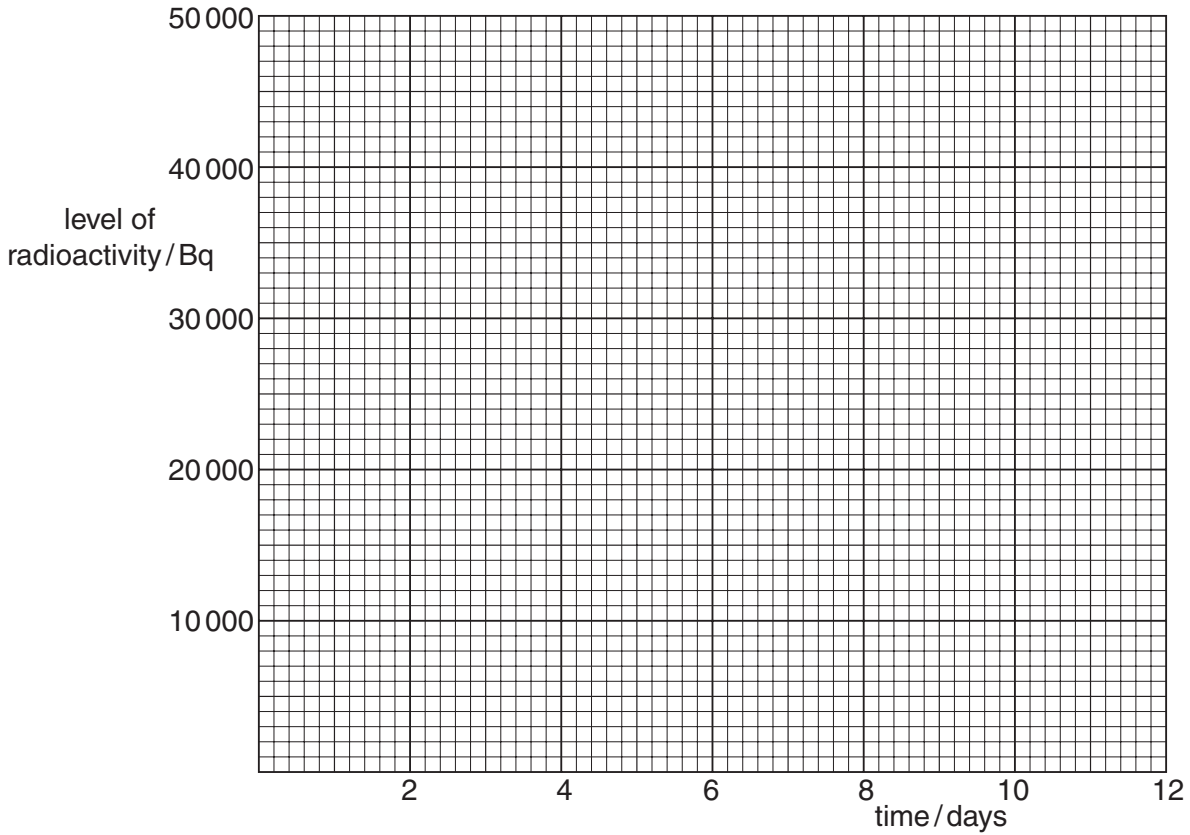


Fig. 2.5

[2]

- (ii) Explain the meaning of the term *half-life*.

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

- (iii) Estimate the half-life of iodine-131.

Show on Fig. 2.5 how you arrive at your answer.

half-life = days [2]

- (iv) The sale of milk from farms around Windscale was banned after the accident.

The level of radioactivity and the half-life of iodine-131 are two pieces of information required when deciding how long such a ban should last.

State **one other** piece of information that would be required.

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

[Total: 19]

- 3 A small number of people are completely colour blind. They see only in shades of grey.

Fig. 3.1 shows the effect of red and blue pigments on beams of white light. People with complete colour blindness see both coloured beams as grey, so cannot tell red and blue apart.

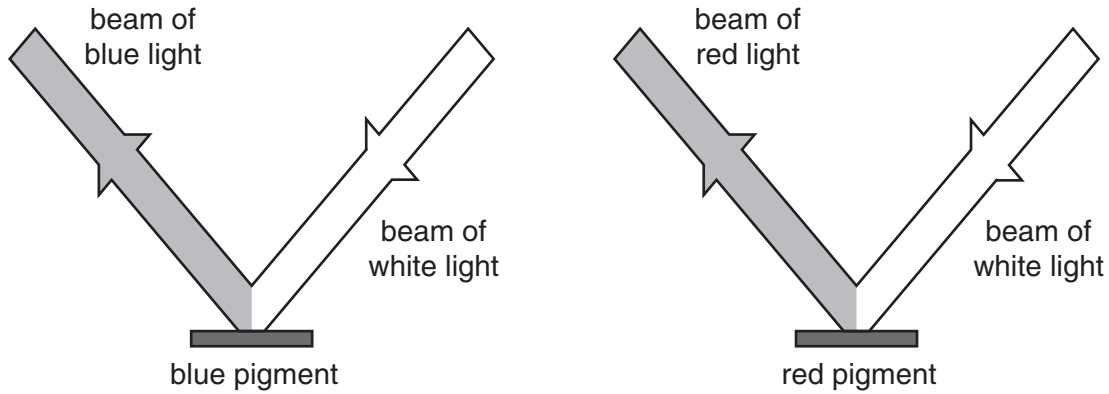


Fig. 3.1

- (a) (i) Describe the difference between the wavelengths of red and blue light.
 [1]
- (ii) State **two** effects that happen when the beams of white light strike the surfaces of the pigments, as shown in Fig. 3.1.
1.
2. [2]
- (iii) Explain why a beam of light can change from white to red or blue when it strikes a pigment.

 [2]

(b) A new invention allows people with complete colour blindness to tell different colours apart. It allows them to 'hear' colours. The invention converts different wavelengths of light into sounds of different pitch. Red light produces a low-pitch note, blue light a high-pitch note.

(i) Visible light is a form of electromagnetic radiation.

Draw a sketch to show a simple wave model of electromagnetic radiation.

Label your sketch to show the meaning of the term *wavelength*.

[2]

(ii) Suggest **one** advantage to a completely colour blind person of being able to tell colours apart.

.....

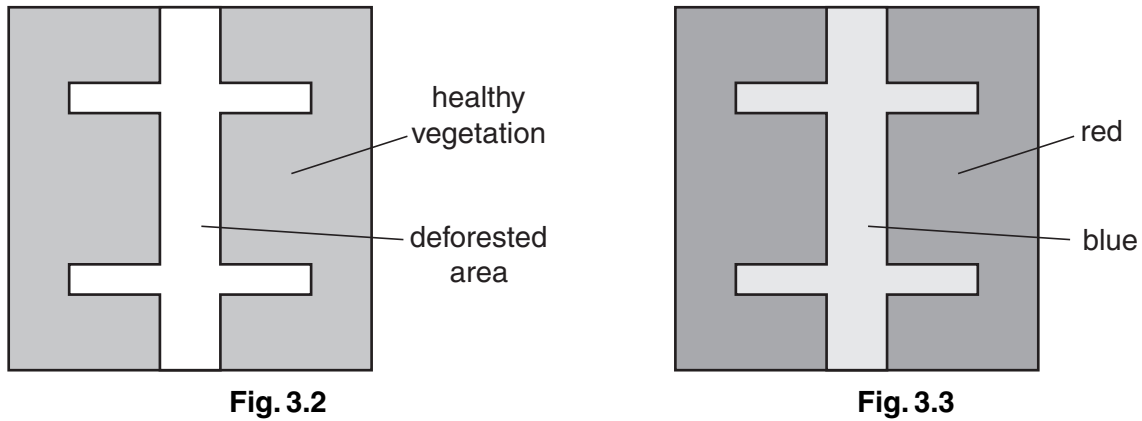
..... [1]

- (c) A false colour image from a remote sensing satellite also displays transformed colours. The reason for doing this is that the eye cannot see some of the wavelengths of radiation that are being sensed.

Fig. 3.2 shows an area of tropical rain forest that is suffering from deforestation.

A satellite senses this area using two wavelength ranges: red light and very near infrared (VNIR) radiation.

Fig. 3.3 shows a false colour image of this area.



- (i) Use this information to complete Fig. 3.4.

wavelength range	intensity of signal		colour assigned in false colour image
	healthy vegetation	soil	
red light	low		
VNIR			

Fig. 3.4 [3]

- (ii) A remotely sensed image, such as Fig. 3.3, consists of an array of squares of different colours and intensities.

What term is used to describe these squares?

..... [1]

- (iii) Satellites used for sensing images, such as those showing deforestation, are called polar orbiting satellites.

State **three** features of the way that these satellites collect information worldwide.

1.

2.

3. [3]

[Total: 15]

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

Describe how the process of natural selection can bring about evolution.

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..... [6]

Quality of Written Communication [2]

(b) The blackcap (*Sylvia atricapilla*) is a species of bird. It is found widespread throughout Europe in summer. Usually it migrates southwards in winter to North Africa. Recently it has been found that blackcaps from Germany have begun to migrate westwards to spend winter in the UK. This is thought to be an adaptation to milder winters in the UK.

Suggest **three** reasons why this adaptation in migratory behaviour has proved advantageous to blackcaps.

1.
.....
2.
.....
3.
..... [3]

[Total: 11]

END OF QUESTION PAPER

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