OCR ADVANCED SUBSIDIARY GCE

IN SCIENCE (3885)

OCR ADVANCED GCE

IN SCIENCE (7885)

Specimen Question Papers and Mark Schemes

These specimen assessment materials are designed to accompany the OCR Advanced Subsidiary GCE and Advanced GCE specifications in Science for teaching from September 2000.

Centres are permitted to copy material from this booklet for their own internal use.

The GCE awarding bodies have prepared new specifications to incorporate the range of features required by new GCE and subject criteria. The specimen assessment material accompanying the new specifications is provided to give centres a reasonable idea of the general shape and character of the planned question papers in advance of the first operational examination.

CONTENTS

Advanced Subsidiary GCE

A2

Oxford Cambridge and RSA Examinations

RECOGNISING ACHIEVEMENT

Advanced Subsidiary GCE

SCIENCE

SCIENCE AND THE NATURAL ENVIRONMENT   **2841**

Specimen Paper

Candidates answer on the question paper

Additional materials:
    To be brought by candidate: electronic calculator

TIME   1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

You may **not** use a Data Book. All necessary data are given as required in the questions.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

You may use an electronic calculator.

You will be awarded marks for the quality of your written communication where an answer requires a piece of extended writing.

1 On 26th April, 1986, an explosion occurred in the nuclear reactor at the nuclear power station at Chernobyl in the USSR. As a result, radioactive material was released into the atmosphere and then deposited over much of Europe and Scandinavia. One of the radioactive isotopes was iodine-131, which emits β^- radiation.

(a) To make sense of the piece of text above you need to know an appropriate model for the structure of an atom. Complete the labels on the diagram below which shows a model of the structure of an atom.

```
┌──────────────────┐                              ┌──────────────────┐
│  .................. │                              │  .................. │
│                    │         ╭─────╮              │                    │
│  containing        │        ╱  ╭─╮  ╲             │  containing        │
│                    │───────▶   │●│               │                    │
│  .................. │        ╲  ╰─╯  ╱◀──         │  .................. │
│  and               │         ╰─────╯             │                    │
│                    │                              └──────────────────┘
│  .................. │
└──────────────────┘
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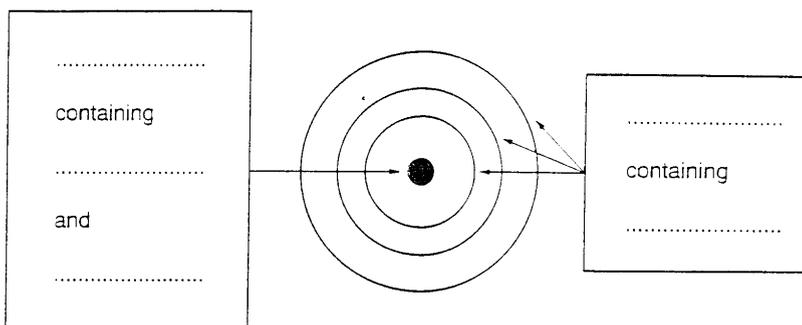
[5]

[5]

(b) Explain what is meant by *radioactive.*

....**[1]**

(c) Explain what is meant by *isotopes.*

....

....**[2]**

(d) Power was generated at the Chernobyl power station by the process of nuclear fission. Describe what is meant by *nuclear fission*.

....

....

....**[2]**

(e) After the Chernobyl incident, people were advised that it was not dangerous to live in areas where radioactive material had been deposited. However, a ban was placed on eating crops and animals fed on grass from these contaminated areas.

(i) Describe the penetrating power of β⁻ radiation.

....……

....**[1]**

(ii) Describe the danger to health of eating food which is contaminated with radioactive material.

....……

....**[2]**

(iii) Assess the validity of the advice given to people who were living in contaminated areas.

....……

....……

....**[2]**

[Total: 15]

2 The Meteosat satellite provides images of the Earth by sensing electromagnetic radiation from two regions of the spectrum - visible and infrared - which cover different wavelength ranges.

(a) In the space below draw a diagram to show what is meant by the wavelength of an electromagnetic wave.

[2]

(b) **(i)** Name **one** region of the electromagnetic spectrum at longer wavelength than the infrared region.

....**[1]**

(ii) Name **one** region of the electromagnetic spectrum at shorter wavelength than the visible region.

....[1]

(c) Images provided by Meteosat are used in weather forecasting. State **two** other uses of remotely sensed images provided by satellites.

....

....

....

....[2]

(d) The Meteosat satellite is in a geostationary orbit. Draw a diagram to show what is meant by *geostationary*.

[2]

[Total : 8]

3 **(a)** Photosynthesis occurs in the chloroplasts in plant cells.

(i) State the energy transfer that takes place in photosynthesis.

....[1]

(ii) Briefly describe how this energy transfer is brought about.

....…

....…

....[3]

(b) **(i)** Name the organelle in which aerobic respiration occurs.

....[1]

(ii) State the energy transfer that takes place in respiration.

....……

....**[1]**

(iii) Briefly describe the function of this energy transfer.

....……

....……

....**[3]**

(c) **(i)** Name **one** other organelle in plant cells.

....**[1]**

(ii) Briefly describe the function of this organelle.

....……

....……

....**[3]**

[Total: 13]

4 Photosynthesis leads to the production of about 300 g of dry organic matter per square metre each year averaged over the Earth. About 15 kJ of energy need to be transferred to a plant for the production of 1 g of dry organic matter. An average of 40 000 kJ of solar energy is available per square metre to plants each year for use in photosynthesis.

(a) Calculate a value for the average percentage of available solar energy which is stored in plants by photosynthesis.

....

....

....**[2]**

(b) State **two** reasons why not all the available solar energy is transferred to plants by photosynthesis.

....

....

..**[2]**

(c) The 300 g of dry organic matter produced per square metre per year is a measure of the average net productivity of plants around the world. In some regions net productivity is higher; in other regions it is lower.

State **two** factors which lead to the net productivity of plants being different in different regions of the world.

....

....**[2]**

Organic matter (biomass) in plants is the source of energy for all consumer organisms and decomposer organisms in an ecosystem, as shown in the diagram below.
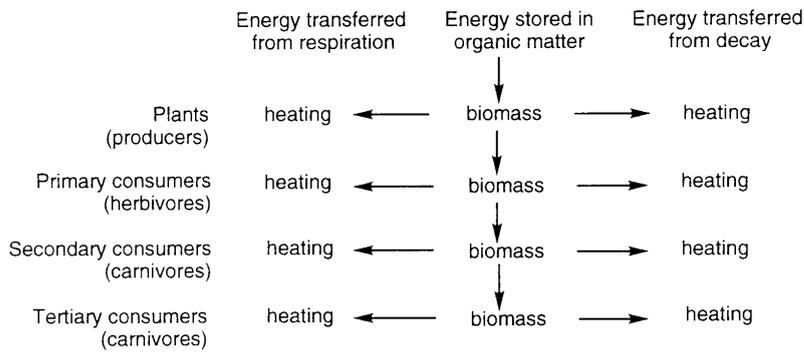
(d) **(i)** How many trophic levels are there in the ecosystem shown in the diagram?

....**[1]**

(ii) State **two** ways in which energy is lost from an ecosystem.

....……

....**[1]**

(e) Explain, in terms of the Second Law of Thermodynamics, why most ecosystems are limited to 3 or 4 trophic levels.

....

....

....

....

....**[3]**

[Total: 11]

5 Giant pandas are now almost extinct. They only live in the damp, cool forests of S. China, where huge areas are covered by bamboo - a species of grass. Although pandas feed almost exclusively on bamboo they are, in fact, carnivores. They are not well adapted to life as herbivores: for example, a panda's digestive system is unable to break down cellulose. Bamboo biomass contains about 7500 kJ kg^{-1}, but pandas can only obtain about 15% of this energy. This inefficient use of food is one reason why pandas' survival is under threat.

The table below compares a giant panda with a giraffe - a typical herbivore. Use the data in the table, where appropriate, to answer the questions which follow.

	Giraffe	Panda
Mass / kg	800	80
Basal metabolic rate (energy required to maintain vital functions: eg, breathing, synthesis of biochemicals, temperature regulation) / kJ day^{-1}	44 000	16 000
Other energy needs (eg, movement, growth, repair) / kJ day^{-1}	40 000	2 700
Feeding rate / kg $hour^{-1}$	1.4	0.8
Time spent feeding / hours day^{-1}	12	18
Length of intestine as multiple of body length	x25	x6

(a) For an 80 kg giant panda, in one day, calculate

   (i) the mass of bamboo eaten;

   ....……

   ....**[1]**

   (ii) the energy intake in the form of bamboo;

   ....**[1]**

   (iii) the energy transferred to the panda from its food.

   ....**[1]**

(b) Suggest **one** reason why such a small proportion of the energy in the bamboo is obtained by pandas' digestive systems.

   ....

   ....**[1]**

(c) Compare the mass of food eaten per day with the basal metabolic rate for both a panda and a giraffe. What evidence does this provide in support of the statement that pandas are carnivores?

....

....

....**[2]**

(d) The energy budget of a panda must obey the First Law of Thermodynamics if it is to survive.

    (i) Write down a statement of the First Law of Thermodynamics.

      ....…

      ....…

      ....**[2]**

    (ii) Comment on the chance of survival of an individual, 80 kg panda in view of its typical, daily energy budget.

      ....…

      ....…

      ....**[2]**

(e) Human activity, especially the clearing of bamboo forests for roads and farming, is hastening the extinction of the panda. Suggest why.

....

....

....**[1]**

[Total: 11]

6 Radioactive tracers can be used to study the progress of atoms of an element through a system. Two radioisotopes of phosphorus are available for use as tracers: ^{30}P (half-life 2.5 minutes) and ^{32}P (half-life 14.3 days).

(a)   **(i)** Explain what is meant by *half-life*.

      ....…

      ....**[2]**

(ii) What percentage of the initial radioactivity of a sample of ^{30}P would remain after 5 minutes?

....**[1]**

(iii) State which isotope of phosphorus would be more suitable for use in an experiment lasting 6 weeks. Explain your answer.

....…

....**[2]**

(b) The existence of isotopes can be shown by a mass spectrometer. Add labels to the diagram below of a mass spectrometer.

A

B

C

D

E

F
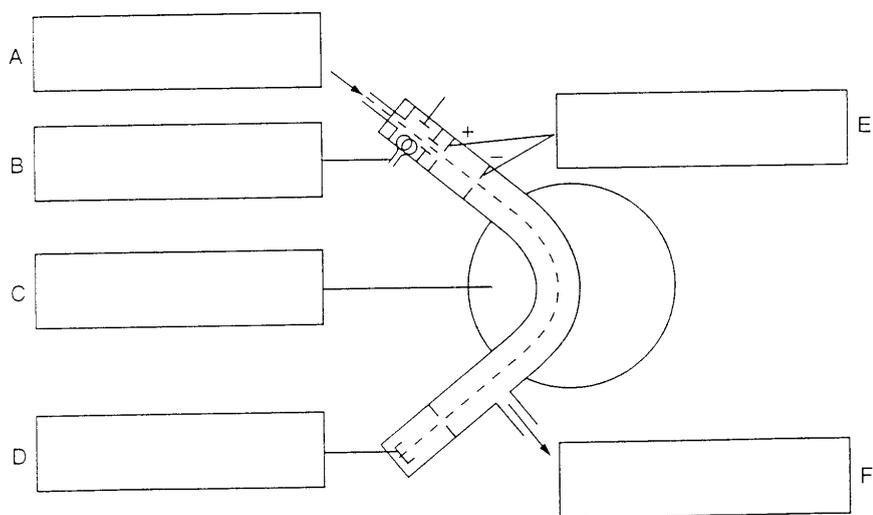
[6]

[Total: 11]

7 The diagram below illustrates a nutrient cycle in a forest ecosystem.
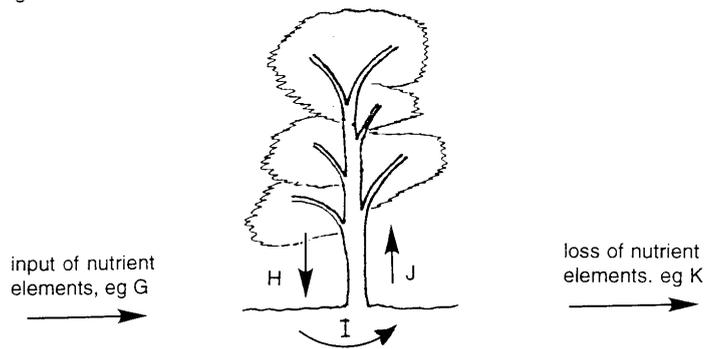
A list of terms relevant to a forest ecosystem follows:

uptake,   *root mass,*   *leaching,*   *carbon dioxide,*
decay,   *weathering,*   *leaf fall,*   *decomposer organisms.*

(a) For each of the processes labelled G to K on the diagram, select a term from the list which best describes that process.

G ....

H ....

I ....

J ....

K ....   **[3]**

(b) Identify **two** processes shown on the diagram which are a source of nutrient elements for plants. (You can identify the processes by their letters.)

....**[1]**

(c) Using information contained in the diagram, explain why *cycle* is an appropriate word to use to describe what happens to nutrient elements in an ecosystem.

....

....**[1]**

(d) A change in one part of a nutrient cycling system leads to changes in another part of the system as a result of negative feedback. Explain what is meant by *negative feedback*.

....

....**[1]**

[Total: 6]

8 (a) The theory of evolution by natural selection was proposed in the nineteenth century by Darwin and Wallace, and has been developed subsequently by other scientists. How does this theory explain the development of new species?

....

....

....

....

....

....**[5]**

(b) Giant senecios - plants belonging to the sunflower family but looking like short palm trees - are found on many mountains in East Africa. The giant senecios found on different mountains belong to different species. No giant senecios are found on the hotter, tropical grassland which surrounds the East African mountains.

Name the factor which has been the cause of the separate evolution of different species of giant senecio on different mountains in East Africa.

....**[1]**

(c) The land at low altitude in Kenya is occupied by tropical rain forest. Describe the structure of a tropical rain forest. (In this question, 4 marks are available for the quality of written communication.)

....

....

....

....

....

....

....

....

....**[9]**

[Total: 15]

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Oxford Cambridge and RSA Examinations

Advanced Subsidiary GCE

SCIENCE

SCIENCE AND THE NATURAL ENIVIRONMENT   **2841**

Mark Scheme

1 (a) The boxes should be completed with the following italicised words

Nucleus 1
containing *protons* 1
and *neutrons* 1

Shells (or orbitals) 1
containing *electrons* 1 **[5]**

(b) Radioactive means undergoing spontaneous nuclear change 1 **[1]**
(Or, the release of α, β or γ emissions)

(c) Isotopes are atoms of the same element 1
containing different numbers of neutrons. 1 **[2]**
(Or atoms of the same element with different mass numbers)

(d) Splitting of the nucleus to form two isotopes 1
or splitting of nucleus to form additional neutrons)
as a result of bombardment by, for, example, neutrons 1 **[2]**

(e) (i) β^- particles have a low penetrating power / are stopped by skin 1 **[1]**

(ii) Radioactive material enters the body as a result of eating 1
emissions can then damage vital organs. 1 **[2]**

(iii) β^- radiation would lead to only a small increase in risk 1
but risk from breathing in or eating radioactive material was significantly increased. 1 **[2]**

[Total:15]

2 (a) Correct transverse waveform drawn 1
with correct, accurate labelling of one wavelength. 1 **[2]**

(b) (i) Microwave 1
radiowave 1
(1 point from the above list) **[1]**

(ii) Ultraviolet 1
X ray 1
γ ray 1
(1 point from the above list) **[1]**

(c) Recording
health of vegetation 1
type of vegetation 1
extent of land cover 1
productivity of seawater 1
extent of algal blooms 1
(2 points from the above 5) **[2]**

(d) Label stating that the satellite remains in a fixed position in relation to the Earth 1
Diagram showing the Earth, the satellite and the area monitored by the satellite. 1 **[2]**

[Total: 8]

3 **(a)** **(i)** Electromagnetic radiation $\rightarrow$ chemical energy (plus heating) 1 **[1]**

(ii) Pigments / chlorophyll 1
absorb 1
red and blue light 1 **[3]**

(b) **(i)** The mitochondrion 1 **[1]**

(ii) Chemical energy $\rightarrow$ chemical energy and heating 1 **[1]**

(iii) The energy transferred as chemical energy is stored in ATP 1
which can be transported elsewhere in the cell 1
to transfer energy for other essential processes 1 **[3]**

(c) **(i)** Rough endoplasmic reticulum /
smooth endoplasmic reticulum /
Golgi bodies /
lysosomes 1 **[1]**

(ii) (RER) information in RNA 1
is translated into protein synthesis 1
building up chains of animo acids 1

(SER) synthesis and 1
transport of 1
lipids 1

(Golgi) modification of / addition of sugar units to 1
proteins 1
prior to transport in or out of cell 1

(lysosomes) contain enzymes 1
which break down 1
obsolete organelles / damaged cells 1

(3 marks max for function of chosen organelle) **[3]**

[Total:13]

4 **(a)** An average of 300 g m^{-2} x 15 kJ m^{-2} = 4500 kJ m^{-2} of energy is stored per year as a result
of photosynthesis; 1
100 x 4500 kJ m^{-2} ÷ 40000 kJ m^{-2} = 11% of the available energy is used in
photosynthesis. 1 **[2]**

(b) Some light is reflected by leaves. 1
Some light is transmitted through leaves / not all wavelengths can be absorbed. 1
Some light misses leaves. 1
Some light falls in winter. 1
(Two points from the above list) **[2]**

(c) Temperature; 1
rainfall;   1
intensity of light;   1
altitude;   1
soil type;   1
availability of nutrients;   1
C4 rather than C3 photosynthesis predominates in some regions;   1
(Two points from the above list) **[2]**

(d) **(i)** There are 4 trophic levels   1 **[1]**

     (ii) Heating from respiration and heating from decay   1 **[1]**

(e) Statement of the Second Law:
In any energy transfer a proportion of energy is transferred to a less useful form
Or: Any energy transfer results in an increase in entropy
Or: Any energy transfer involves an increase in disordered energy 1

Percentage of useful energy transferred between trophic levels is small / about 10%   1
Beyond the 3rd or 4th tropic level not enough energy is available for
biomass formation   1 **[3]**

[Total:11]

5 **(a)** **(i)** $0.8 \text{ kg hour}^{-1} \times 18 \text{ hours} = 14.4 \text{ kg}$ 1 **[1]**

     (ii) $14.4 \text{ kg} \times 7500 \text{ kJ kg}^{-1} = 108\,000 \text{ kJ}$ 1 **[1]**

     (iii) $108\,000 \text{ kJ} \times 15\% = 16\,200 \text{ kJ}$ 1 **[1]**

(b) The system lacks enzymes to digest cellulose.
Or: Food passes quickly through the panda's digestive system because it is so short. 1 **[1]**

(c) A giraffe eats only a little more (16.8 kg) in a day than a panda.   1
However, this supplies over four times as much energy.   1 **[2]**

(d) **(i)** The energy before and after a process   1
must be equal   1

     Or: In any energy transfer   1
energy is conserved   1

     Or: In any energy transfer   1
energy is neither created nor destroyed   1 **[2]**

     (ii) There is almost no energy available for other processes: eg growth and repair   1
the panda is likely to be diseased / unhealthy / die   1 **[2]**

(e) Feeding grounds are being lost and pandas do not have the energy needed
to move to new areas   1 **[1]**

[Total:11]

6 **(a)** **(i)** The time taken from the activity of a sample 1
to fall to half of its initial value. 1 **[2]**

(ii) 25% 1 **[1]**

(iii) ^{32}P 1
It will still be decaying at a detectable rate / the other isotope will be undetectable. 1**[2]**

(b) A: sample inlet 1
B: electron gun / electron source 1
C: magnetic field 1
D: detector 1
E: electric field / accelerating plates 1
F: pump 1 **[6]**

[Total: 11]

7 **(a)** G is weathering
H is leaf fall
I is decay
J is uptake
K is leaching
(All 5 correct - 3 marks; 4 correct - 2 marks; 3/2 correct - 1 mark) **[3]**

(b) G and I 1 **[1]**

(c) Nutrients are lost from the plants in H and are regained by them in J 1 **[1]**

(d) A change to the system leads to an **opposing** change by the system
(or equivalent wording). 1 **[1]**

[Total: 6]

8 **(a)** The Theory of Evolution proposes:
that random mutations arise among individuals 1
some of these individuals are better adapted to their environment 1
which gives them an increased chance of survival 1
if the characteristic is passed on to offspring through reproduction 1
natural selection of individuals with the better adapted characteristic 1
leads eventually to an entire population possessing the new characteristic 1
(Any 5 of the above points) **[5]**

(b) Geographical isolation has led to the evolution of new specie s in this case. 1 **[1]**

(c) Quality of written communication:
Clear and coherent organisation of information 1
Specialist vocabulary used appropriately (emergent, canopy, sub-canopy, forest floor). 1
Text is legible 1
Spelling, punctuation, grammar are accurate 1

Explanation:

Selecting reference to height   1
One correct value for height quoted (eg. 60 m canopy). 1
Selecting reference to light levels.   1
One count quoted light level (eg. low on forest floor). 1
Clear description of layered structure of rain forest.   1   **[9]**

[Total:15]

Oxford Cambridge and RSA Examinations

Advanced Subsidiary GCE

SCIENCE

SCIENCE AND HUMAN ACTIVITY **2842**

Specimen Paper

Candidates answer on the question paper
Additional materials:
    To be brought by candidate: electronic calculator

TIME   1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

You may **not** use a Data Book. All necessary data are given as required in the questions.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

You may use an electronic calculator.

You will be awarded marks for the quality of your written communication where an answer requires a piece of extended writing.

1 **(a)** The diagram below contains information about atmospheric pressures and wind directions in the northern hemisphere.
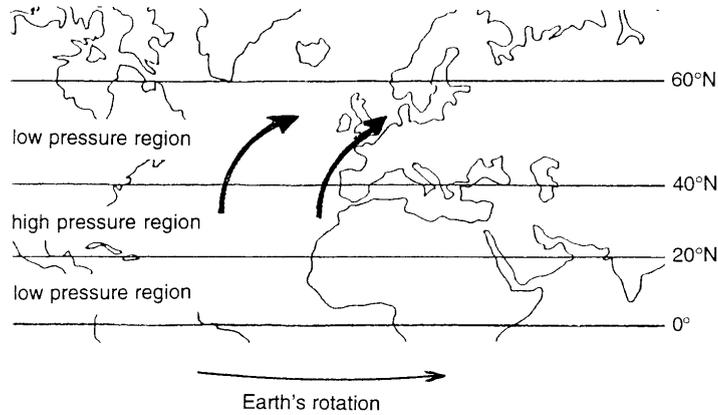
Use information in the diagram to explain why the prevailing winds in the UK blow from SW to NE.

....

....

....

....**[4]**

(b) The movement of air at higher levels in the troposphere can be studied using balloons containing helium. These are assembled at ground level, sealed and only partly inflated. The balloon expands as it rises, eventually becoming fully inflated.

(i) Explain why a helium balloon expands as it rises through the atmosphere.

....…

....**[2]**

(ii) As a balloon expands, the helium cools.
Explain why a gas cools when it expands.

....…

....…

....**[3]**

[Total: 9]

2 The problem of acid rain (or more correctly acid deposition) is serious in many parts of the world, and compounds containing oxidised sulphur are among the handful of chemicals involved. As well as arising from the combustion of fossil fuels, it is now thought that dimethyl sulphide $(CH_3)_2S$, produced by seaweeds and other marine algae, also gives rise to acid deposition. Dimethyl sulphide is a volatile liquid and quickly finds its way into the atmosphere, where it is partly responsible for the smell of sea air. Once in the atmosphere, it can be oxidised to form acidic sulphur compounds.

(a) Explain why acid rain is more correctly termed *acid deposition*.

....

....

....**[2]**

(b) Explain how acid deposition can arise from the burning of fossil fuels.

....

....

....**[2]**

(c) Two of the compounds produced in the atmosphere from dimethyl sulphide have formulae $(CH_3)_2SO$ and SO_2. Explain why the formation of these compounds can be described as oxidation.

....

....**[1]**

(d) The compounds which are responsible for acid deposition are weak acids.

  (i) Explain the meaning of the word *acid*.

....….

....**[2]**

  (ii) How would the pH of a solution of a weak acid compare with the pH of a solution of a strong acid of the same concentration?

....**[1]**

(e) Release of Al^{3+} ions from soil into lake water is one environmental problem that can arise from acid deposition. Solutions of aluminium compounds are toxic to fish.

    (i) Draw a labelled diagram to show the scientific model of a solution of an ionic compound.

                                                                                                        [5]

    (ii) Complete the equation below for the release of Al^{3+} ions from soil in the presence of an acidic solution.

$$\boxed{\begin{array}{c} Al^{3+} \\ \text{humus} \end{array}} \; + \; \text{..........} \; \longrightarrow \; \boxed{\begin{array}{c} \text{..........} \\ \text{humus} \end{array}} \; + \; \text{..........}$$
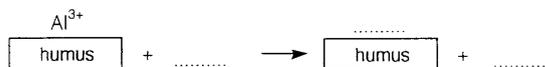
                                                                                                    [2]

    (iii) Describe **one** other environmental problem caused by acid deposition.

        ....

        ....**[2]**

                                                                              [Total: 17]

3 Transmission of electricity in non-urban areas uses overhead wires rather than underground cables. The overhead method is considerably cheaper and, if done properly, is as safe. One important safety consideration is that wires must be supported by pylons to prevent them falling to the ground under the influence of the Earth's gravitational field.

(a) What property of an overhead wire is acted on by the Earth's gravitational field?

....[1]

(b) Explain, in terms of the Earth's gravitational field, why an overhead wire will fall to the ground if not properly supported.

....

....

....[2]

(c) What energy transfer takes place as a wire which was supported falls to the ground?

....[1]

(d) The electric field strength, at ground level, from a wire in an overhead power line depends on the height of the wire above the ground and on its voltage.
State whether the electric field strength increases or decreases when

   (i) the height of the wire above the ground increases;

....

....[1]

   (ii) the voltage of the wire increases.

....

....[1]

(e) An overhead power line typically consists of several wires. The current flows in opposite directions in neighbouring wires at any instant. This is done to reduce the strength of the magnetic field from the power line.

   (i) Explain why this lowers the magnetic field strength.

....

....[1]

(ii) Describe **one** advantage of having a reduced magnetic field strength.

....…

....**[1]**

(iii) State **one** other factor on which the magnetic field strength from an overhead power line depends.

....**[1]**

(f) Transmission of electric power in the UK takes place in the form of a.c. electricity. 'Supergrid' conductors carry currents of about 10 000 A at a voltage of 400 000 V. The peak voltage in these 'supergrid' conductors is close to 565 000 V and the peak current is close to 14 000 A.

(i) Describe, using a diagram, the waveform of an a.c. current. Use your diagram to show how, for an a.c. current of 10 000 A, the peak current is close to 14 000 A.

[3]

(ii) Calculate the power carried by a 'supergrid' electricity conductor.

....…

....…

....**[3]**

[Total: 15]

4 Ethanoic acid (acetic acid) is best known to the general public as the food preservative, vinegar. But it is also used in huge quantities as a 'building block' in the manufacture of other chemicals.

Production of ethanoic acid at BP Chemicals' Hull site takes place in three chemical plants called A4, A5 and DF. These produce a total of 600 000 tonnes of ethanoic acid per year.

In the A4 and A5 plants, carbon monoxide is reacted with methanol to make ethanoic acid:

$$CO + CH_3OH \rightarrow CH_3COOH$$

This process uses a rhodium / iodine catalyst and takes place at a temperature of about 45O K and a pressure of about 30 atmospheres. The catalyst is expensive but the process is very specific, giving a 99% yield of ethanoic acid.

In the DF plant, ethanoic acid is made from naphtha, which is one of the hydrocarbon fractions obtained in petroleum refining. The naphtha is oxidised by air, also at 450 K but at a pressure of 50 atmospheres. No catalyst is used and the reaction produces about 50% ethanoic acid, together with a range of other carbon-containing products. Some of these can be sold; others cannot.

Much of the ethanoic acid produced and the raw materials used in the plants is transported by sea. 240 000 tonnes per year of methanol and 350 000 tonnes per year of naphtha are brought in by bulk tanker. 330 000 tonnes per year of ethanoic acid is exported by sea. The carbon monoxide used in the A4 and A5 plants is made on site from natural gas (methane), which arrives by pipeline.

(a) Two of the plants for production of ethanoic acid use a catalyst.
What is a catalyst?

....

....

....

....**[3]**

(b) All the ethanoic acid manufacturing processes use conditions above room temperature to speed up the rates of the chemical reactions involved. Explain, in terms of collisions between molecules, why increasing temperature leads to an increase in reaction rate.

....

....

....**[2]**

(c) Suggest **one** reason why the site at Hull became the location for a large chemical factory.

....

....**[1]**

(d) In future, the DF plant will be closed down. One reason for this is that the process used in the A4 and A5 plants places a lower burden on the environment. Suggest **one** way in which this process lowers the burden on the environment and give the reason for this.

....

....

....**[1]**

(e) Some of the material produced from the DF process cannot be sold. This material is not disposed of as waste (e.g. by emission to the atmosphere) as this would put too great a burden on the environment. Suggest **one** more suitable method for the management of this waste material.

....

....**[1]**

[Total: 8]

5 A molecule of ethanoic acid can be represented by the model shown below.
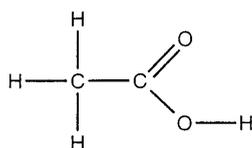
(a) Explain what this model tells us about the structure and bonding in a molecule of ethanoic acid.

....

....

....

....**[4]**

(b) **(i)** What does the term *lone pair* mean when used in connection with the electrons in a molecule?

....

....**[1]**

(ii) How many lone pairs of electrons are present on the oxygen atom of the O-H group in ethanoic acid?

....[1]

(c) **(i)** What is the value of the H-C-H bond angle around the C atom in the CH_3 group of ethanoic acid?

....[1]

(ii) Explain your answer to **(c) (i).**

....…

....…

....[2]

(iii) What is the value of the bond angles around the other C atom of ethanoic acid?

....[1]

[Total: 10]

6 The hydroxyl radical (OH•) is one of the most important chemicals for removing pollutants from the atmosphere even though its concentration (about 10^{-8} ppm) is extremely low. Recent studies of atmospheric carbon monoxide (CO) levels have revealed just how effective OH• radicals are. Hydroxyl radicals convert carbon monoxide into carbon dioxide:

$$CO + OH• \rightarrow CO_2 + H•$$
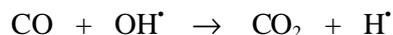
Despite a big increase in carbon monoxide emissions over the past 150 years, the concentration of carbon monoxide in the atmosphere has hardly increased.

(a) The data below show how the concentration of hydroxyl radicals changed with time in an experiment to study the reaction of OH• radicals and carbon monoxide molecules. The concentration of carbon monoxide in this experiment was 2.0×10^{18} molecules m^{-3}.

Concentration of OH• radicals / 10^{16} molecules m^{-3}	Time / s
2.0	0.0
1.5	1.0
1.1	2.0
0.8	3.0
0.6	4.0
0.3	6.0
0.2	8.0

(i) Use these data to plot a graph to show how the concentration of hydroxyl radicals varies with time in this reaction. Use the vertical axis for the concentration of hydroxyl radicals and the horizontal axis for time.
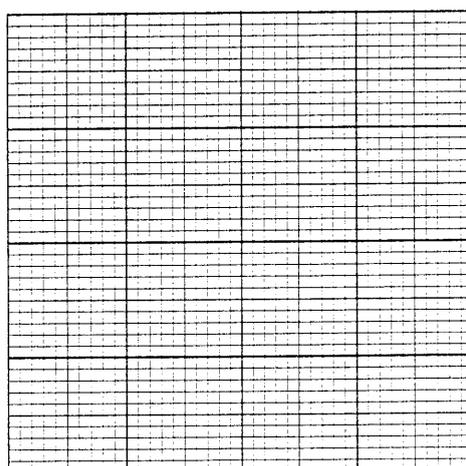
[3]

(ii) Use your graph to estimate **two** values for the half-life for this reaction.

....……

....**[2]**

(iii) Explain how the data show that this reaction is first order with respect to hydroxyl radicals.

....……

....**[2]**

(b) The reaction between hydroxyl radicals and carbon monoxide is fast because it has a low activation energy.

Describe what is meant by *activation energy*.

....

....

....

....**[3]**

[Total: 10]

7 The action of an enzyme is specific to a particular compound or type of compound. For example, 'biological' washing powders contain lipase enzymes that catalyse the breakdown of lipids.

(a) **(i)** Explain, in terms of their chemical composition and properties, what lipid molecules are.

....……

....……

....**[2]**

(ii) State **one** function of lipid molecules in cells.

....**[2]**

(b) The diagram below shows part of a ribbon diagram for the structure of a protein.
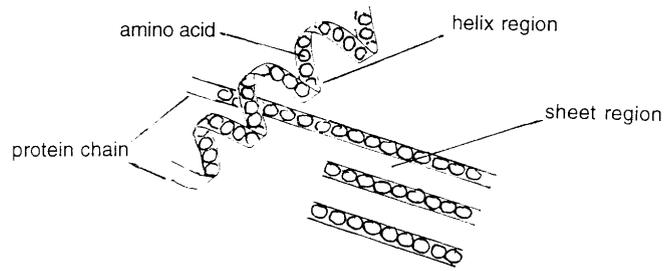
What information shown in the diagram describes

(i) the *primary structure* of the protein;

....……

....**[2]**

(ii) the *secondary structure* of the protein?

....……

....**[2]**

(c) A reaction that is catalysed by an enzyme reaches an optimum rate at a particular temperature. Explain why the rate of an enzyme-catalysed reaction **decreases** if the enzyme is heated **above** a particular temperature. (In this question, 4 marks are available for the quality of written communication.)

....

....

....

....

....

....

....

....

....**[8]**

(d) A company is trying to develop a washing powder containing a lipase enzyme that works in cold water. The company claims that this new product could reduce the environmental burden of clothes washing. Environmental groups argue that such a washing powder could damage the environment.

Give **one** argument for, and **one** argument against, the development of this washing powder.

....

....

....

....

....

....**[4]**

(e) State **one** industrial use of enzymes other than their use in 'biological' washing powders.

....**[1]**

[Total : 21]

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Oxford Cambridge and RSA Examinations

Advanced Subsidiary GCE

SCIENCE

SCIENCE AND HUMAN ACTIVITY   **2842**

Mark Scheme

1 **(a)** Air flows from high pressure to low pressure   1
it starts in a northerly direction from the 20°-40°N region   1
and is deflected to the E / right   1
by the Earth's rotation.   1   **[4]**

   (b) **(i)** The pressure of the atmosphere falls with increasing altitude   1
the helium expands to keep at the same pressure as outside the balloon   1 **[2]**

   (ii) Expanding gas does work against the atmosphere 1
energy is transferred   1
from the thermal energy of the gas   1   **[3]**

                                                                   [Total: 9]

2 **(a)** The acidic pollutants reach the ground both in solution in water (acid rain)   1
and attached to tiny particles of solid (dry deposition). 1   **[2]**

   (b) Coal and oil contain sulphur compounds.   1
When they are burned, combustion of these sulphur compounds forms sulphur dioxide.   1
                                                                            [2]

   (c) In each case oxygen is gained.   1   **[1]**

   (d) **(i)** A compound which dissolves in / reacts with water   1
to produce H^+ ions.   1

   Or: A donor   1
of H^+ ions.   1   2

   (ii) The pH of the weak acid solution would be higher   1   **[1]**

   (e) **(i)** + and - ions shown   1
separated   1
labelled as moving about 1
randomly arranged   1
in the solvent / water   1   **[5]**

   (ii) H^+ ion reactant   1
H^+ bound to humus and Al^{3+} ion released in product   1   **[2]**

   (iii) Erosion 1
of limestone buildings / statues   1   **[2]**
(Or: uncontrolled growth of algae in lakes)

                                                                  [Total : 17]

3 **(a)** The mass   1   **[1]**

(b) The field exerts a force on the mass   1
in the direction of the Earth.   1   **[2]**

(c) Potential energy   ?   kinetic energy   1   **[1]**

(d)   **(i)** Field strength decreases as height increases   1   **[1]**

   (ii) Field strength increases as voltage increases   1   **[1]**

(e)   **(i)** Magnetic fields cancel when currents are in opposite directions   1   **[1]**

   (ii) Reduced power losses during electricity transmission / reduced risk to human health   1
                                                                                            [1]

   (iii) The geometrical arrangement of the wires / the magnitude of the current   1   **[1]**

(f)   **(i)** Correctly drawn waveform and correctly labelled axes   1
Peak current correctly labelled   1
R.m.s. current identified   1   **[3]**
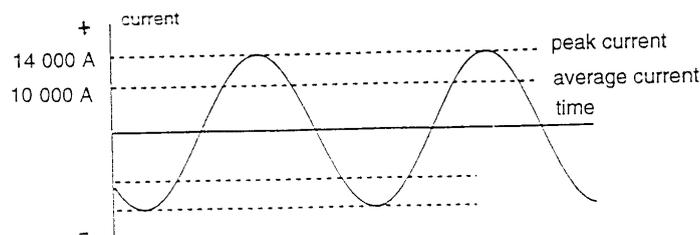
   (ii) $W = V \times I$ 1
Use of r.m.s. values for V and I 1
Power = 4000 MW   1   **[3]**

                                                                          [Total : 15]

4 **(a)** A catalyst is a substance that changes (or speeds up) the rate of a reaction   1
by providing an alternative mechanism   1
with a lower activation energy   1   **[3]**
[2 marks for: " ... changes rate without being used up"]
[1 mark for: " ... changes rate without taking part"]

(b) At higher temperature a greater proportion of molecules   1
have energy equal to or greater than the activation energy   1   **[2]**

(c) It has been convenient to transport the large quantities of materials involved by sea   1
                                                                                            [1]

(d) There is less waste to manage because the A4 & A5 processes are more selective   1

Or other suitable answers: eg. less power is used because in the A4 & A5 processes there is
less need for use of compressors.

Or: less fuel (or power) is used because there is less separation of products to be carried out.

Or: there is a lower risk of leakages of gases because the A4 & A5 processes operate at a lower pressure. **[1]**

    (e) Material could be burned to provide energy and reduce fuel consumption.
(Or: material could be reused / recycled)   1   **[1]**

[Total: 8]

5   **(a)** Discussion of types of atoms in an ethanoic acid molecule
Eg: molecule contains 2 C atoms, 4 H atoms, 2 O atoms   1

Discussion of order of atoms in an ethanoic acid molecule
Eg: the 2 C atoms are linked, one has 3 H atoms attached   1
the other is attached to the 2 O atoms, one of which is attached to the fourth H atom   1

Discussion of types of bonding (1 mark)
Eg: all bonds are single bonds except the double bond between the C atom and the atom which is not further bonded to the H atom   1   **[4]**

    (b)   **(i)** A pair of electrons not involved in covalent bonding   1   **[1]**

        (ii) Two lone pairs on the O atom of O-H   1   **[1]**

    (c)   **(i)** 109°   1   **[1]**

        (ii) There are 4 sets (or separate pairs) of electrons around this C atom   1
this angle gives the maximum separation / minimum repulsion between electron pairs 1
[2]

      (iii) 120°   1   **[1]**

[Total: 10]

6   **(a)**   **(i)** For correct labels and scales on axes   1
For correctly plotted data   1
For best fit line   1   **[3]**

        (ii) For estimate of half-life from 2.0×10^{16} to 1.0×10^{16} molecules m^{-3}
(2.1 to 2.3 s)   1
For second estimate of half-life (2.0 to 2.4 s)
(most likely from 1.0×10^{16} to 0.5×16^{16} molecules m^{-3})   1   **[2]**

      (iii) The half-life is constant. 1
Over a half-life, half as much reactant is used when only half as much is initially present. 1   **[2]**

(b) Activation energy is the minimum energy   1
that must be possessed on collision   1
for particles to react   1   **[3]**

                                                                  [Total: 10]

7   **(a)**   **(i)** Lipids are compounds containing C, H and O   1
                 with a low proportion of oxygen. 1
                 They are insoluble in water.   1   **[3]**

         (ii) As an energy store / as the major component of a plasma membrane.   1   **[1]**

   (b)   **(i)** The **sequence** in the protein **chain**   1
                 of **amino acid** residues   1   **[2]**

         (ii) Regions of **helix** 1
                 or **sheet** in the protein structure.   1   **[2]**

   (c) Quality of written communication:
Clear and coherent organisation of information   1
Specialist vocabulary used appropriately: active site, enzyme-substrate complex, activation energy   1
Text is legible   1
Spelling, punctuation, grammar are accurate   1

Explanation:
the precise match of enzyme and substrate shapes is lost on heating   1
the weak bonding holding the tertiary structure in place is broken by heating   1
rate depends on activation energy   1
activation energy is lower for the enzyme-substrate complex   1   **[8]**

   (d) For the use of the new washing powder:
washing in cold water would reduce   1
fuel consumption   1

Against:
peak activity occurs at the temperature of aquatic ecosystems   1
breakdown of lipid molecules in living organisms could occur   1   **[4]**

   (e) Hydrolysis of starch / sugar inversion / brewing / bread making / bio-stoning   1   **[1]**

                                                                    [Total: 21]

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Oxford Cambridge and RSA Examinations

Advanced Subsidiary GCE

SCIENCE

INTERPRETING SCIENTIFIC INFORMATION   **2843/01**

Specimen Paper

Additional materials:
    Answer paper
    String or treasury tag
    To be brought by candidate: electronic calculator

TIME 1 hour

INSTRUCTIONS TO CANDIDATES

Write your answers on the separate answer paper provided

If you use more than one sheet of paper, fasten the sheets together.

There is **one** question in this paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each part question.

You may use an electronic calculator.

Answer **all** parts of this question.

1 This question refers to the article 'Tropical deforestation and habitat fragmentation in the Amazon: satellite data from 1978 - 1988'. This is abridged from an article by D Skole and C Tucker which appeared in *Science* (25 June 1993).

A copy of the article is provided as an insert to this question paper.

Read the article carefully before you answer this question.

(a) In the Introduction to the article what reasons do the authors give for carrying out their study? **[4]**

(b) Describe briefly how destruction of forest can lead to an increase in the amount of carbon dioxide in the atmosphere. **[7]**

(c) **(i)** How do the authors of the article explain the fact that destruction of tropical forest in particular leads to a huge reduction in biodiversity? **[2]**

(ii) Suggest **one** reason why the fragmentation of habitats might also lead to a reduction in biodiversity. **[2]**

(iii) State **three** reasons why there is a reduction in biodiversity towards the edges of forested areas. **[3]**

(d) In their article the authors compare the results of surveys of the Brazilian Amazon.

(i) What is the total area of the Amazon Basin of Brazil, as given by legal definition? **[1]**

(ii) Into which three types of land is this region subdivided? **[3]**

(iii) Draw up a table to compare the results of the different surveys quoted in the article. **[7]**

(iv) In what three ways do these data suggest that there is a need for a further survey of the region? **[6]**

(v) What units are used in this article for rate of deforestation? **[1]**

(vi) Suggest why different studies have produced such a wide range of estimates of the rate of deforestation. **[2]**

(e) The authors made their measurements of area and rate of deforestation from a *mosaic* of remotely-sensed *single channel images* from Landsat TM.

    (i) Explain the meanings of the two terms in italics. **[6]**

    (ii) Which channel of Landsat TM provided these particular images? **[1]**

    (iii) Use the diagram of the electromagnetic spectrum shown below to state the type of radiation detected in this channel. **[2]**
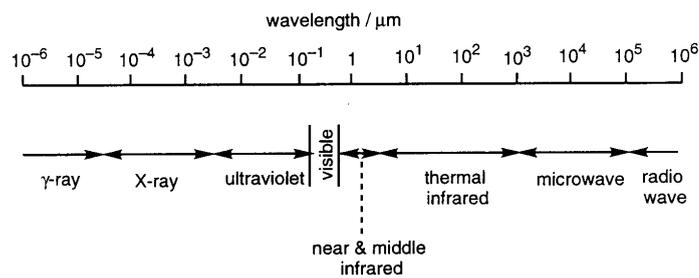
    (iv) Suggest why this type of radiation is particularly useful for recognising tropical forest. **[3]**

(f) The authors used the data-set acquired from 1988 satellite imagery to estimate the extent of deforestation at that time.

    (i) State **three** further categories of land, other than fragmented forest and forest boundaries, that the authors classify as deforested. **[3]**

    (ii) What estimate do the authors give for total area of deforestation in 1988? **[1]**

    (iii) What estimate do the authors give for the rate of deforestation between 1978 and 1988? **[1]**

    (iv) Explain how their results compare with those obtained from earlier studies. **[3]**

    (v) What conclusions do the authors draw about the impact of deforestation on tropical forest habitats in the Brazilian Amazon? **[2]**

[Total: 60]

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Oxford Cambridge and RSA Examinations

Advanced Subsidiary GCE

SCIENCE

INTERPRETING SCIENTIFIC INFORMATION   **2843/01**

Specimen Paper (Insert)

Additional materials:
   Answer paper
   String or treasury tag
   To be brought by candidate: electronic calculator

TIME 1 hour

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Write your answers on the separate answer paper provided

If you use more than one sheet of paper, fasten the sheets together.

There is **one** question in this paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each part question.

You may use an electronic calculator.

TROPICAL DEFORESTATION AND HABITAT FRAGMENTATION IN THE AMAZON: SATELLITE DATA FROM 1978 - 1988

Introduction

Deforestation has been occurring in temperate and tropical regions throughout history. In recent years, much attention has focused on tropical forests, where as much as 50% of the original extent may have been lost to deforestation in the last two decades, primarily as a result of agricultural expansion. Global estimates of tropical deforestation range from 69 000 km^2 $year^{-1}$ in 1980 to 100 000 to 165 000 km^2 $year^{-1}$ in the late 1980s; 50 - 70% of the more recent estimates have been attributed to deforestation in the Brazilian Amazon, the largest region of continuous tropical forest in the world.

The area and rate of deforestation in Amazonia are not well known, nor are there quantitative measurements of the effect of deforestation on habitat degradation. We used 1:500 000 scale photographic imagery from Landsat Thematic Mapper data and a geographic information system (GIS) to create a computerized map of deforestation and evaluate its influence on forest fragmentation and habitat degradation.

Background

Tropical deforestation is a major component of the carbon cycle and has profound implications for biological diversity. Deforestation increases atmospheric CO_2 and other trace gases, possibly affecting climate. Conversion of forest to cropland and pasture results in a net flux of carbon to the atmosphere because the concentration of carbon in forests is higher than that in the agricultural cycles that replace them. The paucity of data on tropical deforestation limits our understanding of the carbon cycle and possible climate change. Furthermore, whilst occupying less than 7% of the terrestrial surface, tropical forests are the home to half or more of all plant and animal species. The primary adverse effect of tropical deforestation is massive extinction of species including, for the first time, large numbers of vascular plant species.

Deforestation affects biological diversity in three ways: destruction of habitat, isolation of fragments of formerly contiguous habitat, and edge effects within a boundary zone between forest and deforested areas. This boundary zone extends some distance into the remaining forest. In this zone there are greater exposure to winds; dramatic micrometeorological differences over short distances; easier access for livestock, other animals and hunters; and a range of other biological and physical effects. The result is a net loss of plant and animal species in edge areas.

There is a wide range in current estimates of the area and rate of deforestation in Amazonia. Scientists at the Instituto Nacional de Pesquisas Espaciais estimated a total deforested area of 280 000 km^2 as of 1988 and an average annual rate of 21 000 km^2 $year^{-1}$ from 1978-1988. Other studies have reported rates that range from 50 000 - 80 000 km^2 $year^{-1}$.

The Amazon Basin of Brazil, as defined by law, covers an area of about 5 000 000 km^2, of which 4 090 000 km^2 is forested, about 850 000 km^2 is cerrado or tropical savana, and about 90 000 km^2 is water. Confusion has arisen among researchers regarding the stratification of the Brazilian Amazon into forest, cerrado and water strata. A Food and Agriculture Organisation (FAO) - United Nations Environmental Program (UNEP) study found 3 562 800 km^2 of forest, whereas Fearnside and co-workers claim there is 4 195 660 km^2 of forest, 793 279 km^2 of cerrado and 4 906 784 km^2 total. Meanwhile, an IBGE study found 20 972 km^2 of water, 3 793 664 km^2 of forest, and 1 149 943 km^2 of cerrado for a total of 4 964 920 km^2. These differences prevent comparison of different deforestation studies.

The use of satellite data and the GIS make it possible to explicitly stratify Amazonia on the basis of cover types, thereby providing a means of comparison with other studies. This approach is also necessary for spatial analysis of habitat fragmentation and edge effects of deforestation.

Remote sensing

We acquired 210 black and white photographic images of the entire Brazilian Amazon. They were obtained with channel five of the Landsat Thematic Mapper (1.55 to
1.75 ? m) and were primarily from 1988. We digitised the deforested areas with visual deforestation interpretation and standard GIS techniques. The digitised scenes were projected into equal-area geographic coordinates (latitude, longitude) edge-matched and merged into the computer to form a single, seamless data-set for the entire Brazilian Amazon.

We extracted forest fragments <100 km^2 that were isolated by deforestation and computed edge effect for a zone of 1 km^2 along the boundaries. All areas of closed-canopy tropical forest deforested by 1988 were delineated, including areas of secondary growth on abandoned fields and pastures where visible. Areas of long-term forest degradation along river margins in central Amazonia were also included, as were small, scattered clearing associated with rubber tappers, mining operations, airfields and other small disturbances. All visible roads, power line rights of way, pipelines and other similar man-made features were also digitised into the GIS and treated as deforestation.

To determine the extent of deforestation in 1978, we used the GIS to digitise maps from single channel Landsat MSS data, produced jointly by the Instituto Brasiliero de Desenvolvimento Florestal (IBDF) and the Instituto de Pesquisas Espaciais (INPE) in the early 1980s.

Deforestation and forest fragmentation

Distribution of deforestation and affected habitat in the Brazilian Amazon for 1978 and 1988 was concentrated in a crescent along the southern and eastern fringe of the Amazon (a spatial pattern similar to the distribution of fires observed from thermal anomalies in data from Landsat's Advanced Very-High Resolution Radiometer (AVHRR) and along major transportation corridors in the interior of the Amazon. Deforestation increased between 1978 and 1988 (78 000 to 23 000 km^2) while the total affected habitat increased (208 000 to 588 000 km^2). The total area deforested increased by a factor of two to three or more in every state except Amapa; but it is likely that the deforested area in Amapa is higher than our estimation because excessive cloud cover in this region prevented complete analysis. We found that 6% of closed-canopy forest had been cleared as of 1988 and about 15% of the forested Amazon was affected by deforestation-caused habitat destruction, habitat isolation and edge effects.

For the entire Brazilian Amazon, our deforestation estimate is close to, but lower than, the estimates of Fearnside et al. and the INPE, of 280 000 km^2 as of 1988. The difference is as a result of three factors: (i) different stratification of forest, cerrado and water; (ii) slightly different estimates of secondary growth, which is spectrally similar to intact forest in channel five; and (iii) positional accuracy, interpretation and boundary generalisation. By comparison, our analysis suggests that deforestation estimates based on coarse-resolution meteorological satellite data in the southern Amazon of Brazil have overestimated deforestation by about 50%.

Our estimates can be used in the assessments of net flux of carbon from land clearing and biomass burning in the Brazilian Amazon. Current estimates of these fluxes have largely been based on model calculations with deforestation values much higher than we report.

The preponderance of affected habitat results from proximity to areas of deforestation (about 341 000 km^2 for a 1-km edge effect) and not from isolation of forest (about 15 000 km^2) or deforestation per se (230 000 km^2). While the rate of deforestation averaged about 15 000 km^2 year^{-1} in the Brazilian Amazon from 1978-1988, the rate of habitat fragmentation and degradation was about 38 000 km^2 year^{-1}. Implications for biological diversity are not encouraging and provide added impetus for the minimisation of tropical deforestation.

Abridged from an article by D. Stole and C. Tucker which appeared in Science: Vol 260 : 25 June 1993

Oxford Cambridge and RSA Examinations

Advanced Subsidiary GCE

SCIENCE

INTERPRETING SCIENTIFIC INFORMATION   **2843/01**

Mark Scheme

1 **(a)** Area 1
and rate of deforestation are not well known.   1
No quantitative measurements 1
of the effects of deforestation on habitat degradation have so far been made.   1   **[4]**

(b) Plants take in carbon dioxide   1
from the atmosphere   1
by photosynthesis.   1
When forests are cut down   1
photosynthesis ceases.   1
When trees are burned   1
carbon dioxide is released into the atmosphere.   1   **[7]**

(c) **(i)** Tropical forest covers 7% of the Earth's surface   1
but contains more than 50% of all plant and animal species.   1   **[2]**

(ii) Fragmentation of a habitat is likely to disturb   1
the food chain.   1   **[2]**

(iii) Greater exposure to winds.   1
Dramatic micrometeorological difference.   1
Easier access for livestock and hunters.   1   **[3]**

(d) **(i)** 5,000,000 km^2.   1   **[1]**

(ii) Forest,   1
cerrado (tropical savanna)   1
and water.   1   **[3]**

(iii)

Name of study	Area / km^2			
	forest	cerrado	water	total
Legal definition	4 090 000	850 000	90 000	5 000 000
FAO-UNEP	3 562 800	-	-	-
Fearnside et al	4 195 660	793 297	-	4 906 784
IBGE	3 793 664	1 149 943	20 972	4 964 920

Correct choice of column and labels:
name of study   1
area   1
forest, cerrado, water, total   1
Correct tabulation of named study and results (1 mark for each)   4   **[7]**

(iv) Disagreement between studies   1
plus example.   1
Discrepancy within studies   1
plus example.   1
Incomplete data-sets   1
plus example.   1   **[6]**

(v) km^2 $year^{-1}$.   1   **[1]**

(vi) The different studies cannot agree on the classification of the different types of area, 1
so are unlikely to produce reliable estimates of rate of deforestation.   1   **[2]**

(e)   **(i)** Mosaic: an image   1
compiled from fragments 1
of other images taken at different times.   1
Single channel image: an image produced by the detection   1
of electro-magnetic radiation   1
from one particular part of the spectrum.   1   **[6]**

  (ii) Channel 5.   1   **[1]**

  (iii) Near-middle   1
infra-red radiation.   1   **[2]**

  (iv) This radiation is strongly absorbed by water.   1
Therefore it differentiates clearly   1
between wet and dry vegetation.   1   **[3]**

(f)   **(i)** Areas of secondary growth on abandoned fields and pastures.   1
Areas of long-term forest degradation along river margins.   1
Clearings associated with industrial or other activities.   1
Roads, power line rights of way, pipelines etc.   1
(Any three points.)   **[3]**

  (ii) 230,000 km^2 1   **[1]**

  (iii) 15,200 km^2 $year^{-1}$ 1   **[1]**

  (iv) Close to, but slightly lower than results of Fearnside et al. 1
Much lower than estimates made from meteorological satellite data.   1
Difficult to compare because other studies disagree on the proportions of different types of cover.   1   **[3]**

  (v) Most effects on habitats due not to deforestation itself   1
but the effect that deforestation has on adjacent areas of forest.   1   **[2]**

[Total:60]

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Oxford Cambridge and RSA Examinations

Advanced GCE

SCIENCE

SCIENCE AND ENVIRONMENTAL MANAGEMENT   **2844**

Specimen Paper

Candidates answer on the question paper

Additional materials:
    To be brought by candidate: electronic calculator

TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

You may **not** use a Data Book. All necessary data are given as required in the questions.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

You may use an electronic calculator.

You will be awarded marks for the quality of your written communication where an answer requires a piece of extended writing.

Answer **all** questions.

1 The phrase 'eat up your greens' has gained a new meaning now that scientists have discovered that some members of the brassica family contain chemicals called glucosinolates that can protect humans against developing certain cancers. Broccoli, for instance, contains a glucosinolate called glucorophanin, and a programme is under way to breed new varieties containing higher levels of this beneficial chemical.

(a) State what is meant by the term *variety*.

....

....**[2]**

(b) The text below contains blank spaces. Fill in these blank spaces using words or phrases from the list that follows. Each word or phrase should be used only once.

doubled	*halved*
randomly	*homologous*
sexual	*gamete*
mitosis	*meiosis*
of each pair of chromosomes	*chromosome from each pair*

"... reproduction is a source of variation. It

brings together .... cells from the parents. These

cells are produced by .... During this process,

cell division occurs twice. In the first cell division, the chromosomes are

.... in number. They then form

.... pairs. One

.... is then pulled into each of the two new cells

which form. Cell division then occurs for a second time. In this stage, one ....

.... is pulled into each of the new cells produced. This

stage therefore resembles the process of ....

As a result, the number of chromosomes in each cell is

.... compared with the original cell. Variation

arises because the assortment of chromosomes occurs

.... in this second cell division".   **[10]**

(c) Wild cabbages contain ten times more glucorophanin that most commercial varieties of broccoli. Describe in outline how wild cabbages could be used to breed a new variety of broccoli which is high in glucorophanin.

....

....

....

....

....

....

....

....

....**[6]**

(d) Brassicas produce glucosinolates to deter predators, but these substances are non-toxic to humans. Some scientists believe that, over a long period of eating an omnivorous diet, humans have adapted to an intake of plant toxins to such an extent that our health suffers if we are deprived of these natural pesticides. This view is not accepted by all scientists.

Give **one** argument for and **one** argument against the theory that humans have evolved to thrive on the natural pesticides produced by some brassicas.

....

....

....

....

....**[4]**

[Total: 22]

2 C4 plants are adapted to grow in tropical regions of the world, where it is hot and light intensity is high. C3 plants are adapted to grow in a temperate climate, where it is cooler and light intensity is lower.

(a) When a C3 plant is grown in hot conditions where light intensity is high, photorespiration leads to loss of plant biomass. Describe the two ways in which photorespiration leads to loss of plant biomass.

....

....

....

....**[4]**

(b) Briefly describe how C4 plants are adapted to prevent photorespiration taking place.

....

....

....

....

....

....

....**[6]**

(c) Explain why wheat, a C3 plant, is the major cereal crop grown commercially in tropical countries.

....

....**[1]**

(d) Agricultural production in tropical countries can be increased by improving the output of small-scale, family farms. One way of achieving this is to breed new, high-yielding varieties of C4 plants, such as sorghum. Suggest **two** reasons for this approach.

....

....

....**[2]**

[Total 13]

3 In the evening of 21st August, 1986, a huge blast of carbon dioxide burst through the surface of Lake Nyos in Cameroon, West Africa. The resulting dense cloud of gas rolled along the land, suffocating thousands of people and animals. The scientific explanation for the Lake Nyos incident is as follows. Carbon dioxide, formed by decomposition of rocks below the lake, seeps out of the rocks and dissolves in the water. The pressure at the bottom of the lake is much greater than that at the surface, and the solubility of carbon dioxide in water is greater at high pressure than at low pressure. Therefore, the concentration of carbon dioxide in the water at the bottom of the lake is higher that its concentration in water at the surface. The Lake Nyos incident arose because something caused the lake water to 'turn over', forcing a large volume of water from the bottom of the lake to the surface. At the lower pressure on the surface, carbon dioxide gas burst out of solution like a large-scale version of opening a pressurised bottle of fizzy drink on a hot day.

(a) Data about the solubility of carbon dioxide in water at different pressures are given in the following table. In these data, pressure is measured in atmospheres (atm).

Pressure / atm	Solubility of carbon dioxide / kg m^{-3}
1.0	1.3
8.0	12.3
12.0	18.5
18.0	27.7
24.0	36.9

(i) Plot the data on the grid below. Use the vertical axis for pressure (in atm) and the horizontal axis for solubility (in kg m^{-3}).
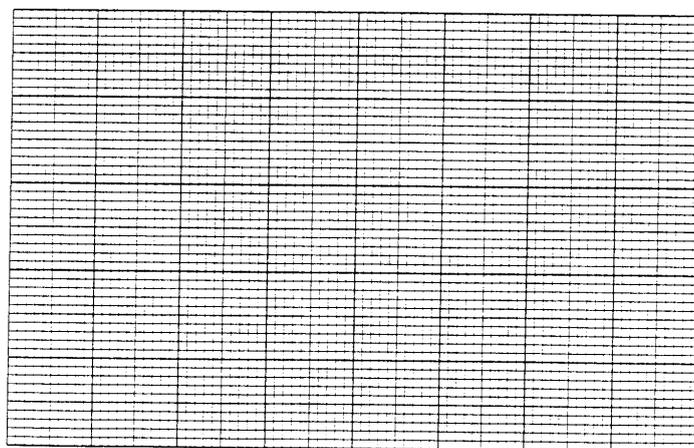
[2]

(ii) Use your graph to estimate the solubility of carbon dioxide in water at the bottom of Lake Nyos where the pressure is 20 atm. Make it clear on the graph how you arrive at your estimate.

Solubility of carbon dioxide = ... in kg m^{-3} **[2]**

(iii) Calculate the mass of carbon dioxide released when 1.0 m^3 of water rises from the bottom of Lake Nyos to the surface.

....

....**[2]**

(iv) Calculate the volume of carbon dioxide produced when 1.0 m^3 of water rises from the bottom of Lake Nyos to the surface.
(1 kg carbon dioxide occupies 0.55 m^3 at atmospheric pressure.)

....

....**[1]**

(v) Assuming that the gas which is released from Lake Nyos forms a cloud of the same area as the lake surface, calculate the depth of the gas cloud which rolled along the land.

....**[1]**

(b) The lower solubility of carbon dioxide in water at low pressures can be explained in terms of entropy changes.

(i) Describe how the entropy of a substance is related to the number of ways of arranging the molecules it contains.

....

....**[1]**

(ii) Describe how the number of ways of arranging the molecules in a solution at low concentration is different from that at high concentration.

....

....

....**[2]**

(iii) What must the overall entropy change be when a process takes place?

....**[1]**

(iv) In terms of concentration and entropy changes, explain why carbon dioxide was released as a cloud of gas when Lake Nyos water 'turned over'.

....

....

....**[2]**

[Total : 14]

4 Recent research has provided information about the communities of algae which have inhabited saltwater lakes in Antarctica over the past 6000 years. The evidence suggests that these algal communities remained fairly stable until about 200 years ago, when they began to change rapidly. Algae are sensitive to the salinity (salt content) of water. Some species tolerate water with a high salinity; others thrive only in fresh water. Over the past 200 years populations of salt-tolerant algae in the lakes have fallen in numbers whereas populations of salt-intolerant algae have arisen.

(a) Salinity is an example of an abiotic factor. Name **two** other abiotic factors.

....

....

....**[2]**

(b) Communities of two species of algae, one salt-tolerant the other salt-intolerant, were established in a series of water samples each with a different salinity. The number of algae of each species was measured in each community. From these measurements it was possible to plot a graph to show how the numbers of the two species of algae varied with salinity. Such a graph is illustrated in Fig. 5.1.
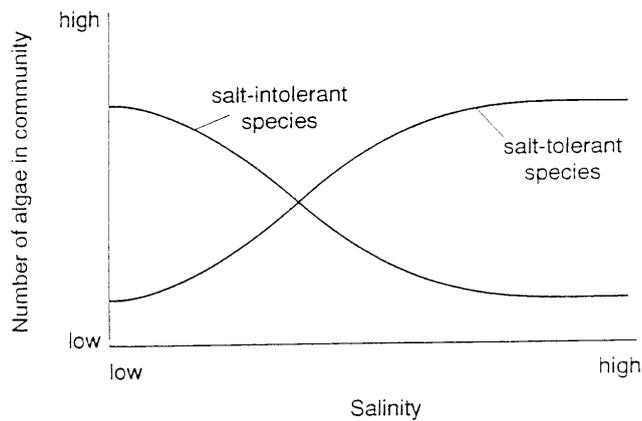

Fig. 5.1

   (i) On Fig. 5.1, draw a line to represent the total number of algae in the community. **[2]**

(ii) Explain why the number of salt-tolerant algae changes with salinity as shown in the graph.

....

....

....

....

....

....**[4]**

(c) There is speculation that the decreased salinity of Antarctic lakes could be a consequence of global warming. Suggest how a warming Earth could cause this decrease in salinity.

....

....**[1]**

[Total: 9]

5 Water in many aquifers is becoming contaminated with pesticides. Samples of water from these aquifers need to be analysed at intervals to make sure that levels of contaminants remain below acceptable limits. Gas-liquid chromatography is one analytical technique that is used.

(a) **(i)** The diagram below illustrates the essential features of gas-liquid chromatography apparatus. Write down what the letters A and B stand for.
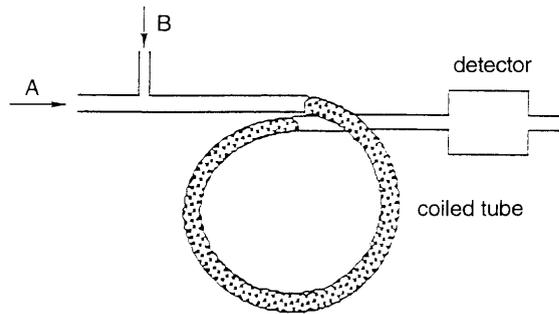
A ....…

B .... **[2]**

(ii) What is contained in the coiled tube?

....

....

....**[3]**

(b) What quantity is used to identify a compound in the results obtained from gas-liquid chromatography?

....**[1]**

(c) The diagram below shows a cross-section through a region where a confined aquifer is likely to form.
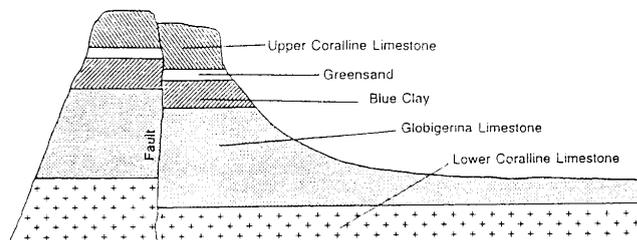
(i) Indicate the position of the confined aquifer on the diagram. **[1]**

(ii) Explain why an aquifer forms in this case.

....

....**[3]**

(d) Water stored in rocks is the largest reserve of freshwater on Earth. Name the next most abundant source of freshwater.

....**[1]**

In the states of North and South Dakota, in the USA, there is not enough drinking water but there is plenty of brackish water in the Dakota aquifer. In brackish water, the concentration of dissolved salts is below that in sea water but in excess of the level permitted for drinking water. Environmental scientists have devised a plan for purifying the brackish water by first freezing it and then allowing the ice to thaw. When brackish water freezes, as it does in the winter conditions in the Dakotas, crystals of pure ice form together with a more concentrated solution of salts. The plan is to store the ice in a reservoir and to allow the salt solution to run off. In the spring and summer, when the temperature is higher, pure water from the melting ice will be supplied from the reservoir.

(e) The change from water to ice is exothermic. Explain what is meant by *exothermic*.

....**[1]**

(f) Freezing is a reversible process. The direction of change in a reversible process can be predicted using Le Chatelier's Principle. Use this Principle to show that the freeze/thaw plan for water purification is correctly based on scientific ideas.

....

....

....

....**[3]**

(g) Disposal of the solution of salts left over after ice has been produced should result in as little burden on the environment as possible. Suggest **one** suitable method for the disposal of this solution of salts.

....

....**[1]**

(h) **(i)** The freeze/thaw method of water purification relies on the freezing conditions which persist for a large part of the year in the Dakotas. Name **one** other method which is employed in warmer climates for desalination of water.

....**[1]**

(ii) Explain why desalination is not suitable for producing water for use in irrigation of agricultural land.

....

....**[1]**

[Total : 18]

6 Several species of crop plant have been genetically engineered so that they produce a protein which is toxic to the insect which causes most damage to the crop. In other words, the plants produce their own insecticide.

(a) A representation of a short section of DNA is shown below. Add labels to the boxes to describe the structure of DNA.

DNA

[2]

(b) Describe, in outline, how the information carried by a gene leads to the production of a particular protein. (In this question, 4 marks are available for the quality of written communication.)

....

....

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....

....

....

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....

....**[10]**

(c) Suggest why concern has arisen that this application of genetic engineering could damage the environment.

....

....

....**[2]**

[Total: 14]

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Oxford Cambridge and RSA Examinations

Advanced GCE

SCIENCE

SCIENCE AND ENVIRONMENTAL MANAGEMENT **2844**

Mark Scheme

1 **(a)** A variety is a group within a species. 1
            that possesses distinctive characteristics.   1   **[2]**

   (b) "*Sexual* reproduction is a source of variation. It brings together *gamete* cells from the parents. These cells are produced by *meiosis.* During this process, cell division occurs twice. In the first cell division, the chromosomes are *doubled* in number. They then form *homologous* pairs. One *of each pair of chromosomes* is then pulled into each of the two new cells which form.

   Cell division then occurs for a second time. In this stage, one *chromosome from each pair* is pulled into each of the new cells produced. This stage therefore resembles the process of *mitosis.* As a result, the number of chromosomes in each cell is *halved* compared with the original cell. Variation arises because the assortment of chromosomes occurs *randomly* in this second cell division".

   (One mark for each correctly used word or phrase shown in italics above)   **[10]**

   (c) Select a wild cabbage plant that contains a high level of glucorophanin.   1

   Select a good commercial variety of broccoli. 1

   Take pollen   1
   from wild cabbage and cross-pollinate   1
   the ova of the broccoli plant   1
   to produce hybrid seed.   1

   Grow hybrid plants from the hybrid seed.   1

   (6 points from the 7 above)   **[6]**

   (d) Argument in favour of evolution theory

   Specific brassica pests exist.   1

   These too must have evolved so that the natural pesticides in brassicas are non-toxic to them.   1

   Argument against the evolution theory

   Humans are much bigger than most plant pests and only eat brassicas as part of their diet.   1

   It may be that small amounts of the pesticides are non-toxic to humans, but that large amounts would be toxic.   1   **[4]**

   [Total: 22]

2 (a) Photorespiration prevents carbon dioxide   1
entering the cycle of reactions from which biomass is produced.   1

Or: oxygen inhibits the enzyme / blocks the active site 1
to which carbon dioxide binds 1   2

Photorespiration also destroys compounds in this cycle 1
by reaction with oxygen. 1   **[4]**

(b) Select reference to:
two stages of photosynthesis   1
importance of oxygen concentrations   1

Present and organise explanation in terms of:
oxygen is produced from first stage of photosynthesis   1
carbon dioxide is needed in second stage   1
carbon dioxide is transported away from oxygen into interior of leaf   1

Correct use of appropriate vocabulary, accurately spelled:
light independent, light dependent, bundle sheath cells, malic acid

(minimum of 2 terms from these 4)   1   **[6]**

(c) Wheat can be sold abroad (or to earn foreign currency)   1   **[1]**

(d) These crops are less likely to fail if conditions are poor.   1

Farmers have expertise at growing such crops. 1

Small-scale farms cannot afford to buy wheat seed.   1

Small-scale farms cannot provide irrigation needed for wheat. 1

(2 points from above 4).   **[2]**

[Total: 13]

3 (a) (i) For correct labels and scales on axes   1
For correctly plotted points and best fit line   1   **[2]**

(ii) Solubility of carbon dioxide $= 31$ kg m^{-3} (allow ± 0.5)   1
Lines on graph to show how value deduced   1   **[2]**

(iii) Surface is at 1 atm, solubility is 1.3 kg m^{-3} 1
Mass released $= 30$ kg m^{-3} (allow ± 1)   1   **[2]**

(iv) Volume $= 16.5$ m^3 1   **[1]**

(v) Depth $= 16.5$ m   1   **[1]**

(b) (i) Entropy increases as the number of ways of arranging the particles increases   1
[1]

(ii) Either an answer based on assumption of a fixed amount of solute:
there are more ways of arranging the molecules at low concentration   1
because more space is available to them.   1

Or an answer based on a fixed volume of solution:
there are fewer ways of arranging the molecules at low concentration   1
because there are fewer molecules to be arranged.   1   **[2]**

(iii) Overall, the entropy increases
(or the overall entropy change must be positive)   1   **[1]**

(iv) Release of carbon dioxide brings about a change from a high concentration
to a lower one   1
which corresponds to an increase in entropy.   1

(Or the entropy of a gas is greater than that of a concentrated solution   1
therefore gas is released to bring about a lower concentration)   1   **[2]**

[Total: 14]

4   **(a)**   Temperature; 1
pH;   1
light intensity;   1
aspect;   1
rainfall;   1
nutrient levels;   1
soil composition;   1
drainage;   1
soil oxygen content   1
(Two points from the above list)   **[2]**

(b)   **(i)**   Horizontal line   1
corresponding to the sum of the two population curves   1   **[2]**

(ii)   There are fixed amounts of nutrients   1
able to support only a fixed number of algae.   1
At lower salinities, competition from the salt-intolerant species   1
reduces the number of salt-tolerant algae;   1   **[4]**

(Or equivalent in terms of competition from salt-tolerant species at high salinities.)

(c)   Ice would melt, adding freshwater to the lakes.
Or: precipitation / snowfall would increase   1   **[1]**

[Total: 9]

5 **(a)** **(i)** A: carrier gas   1
B: sample inlet   1   **[2]**
(or other way round)

(ii) Grains of solid   1
coated with liquid   1
in a thin film   1   **[3]**

(b) Retention time   1   **[1]**

(c) **(i)** Aquifer forms in greensand on either side of fault line   1   **[1]**

(ii) Overlying limestone is permeable   1

Underlying clay is impermeable   1

Greensand is porous   1   **[3]**

(d) Glaciers / ice   1   **[1]**

(e) Exothermic: leads to heating
Or: gives out heat
Or: other acceptable form of words   1   **[1]**

(f) If an alteration is made to the conditions of a reversible system 1
the system opposes the alteration   1
(Or other correct statement of Le Chatelier's Principle)
The endothermic melting process therefore occurs when the temperature rises 1   **[3]**

(g) Release the salt solution into a large volume of water
Or: into the sea
Or: use the salts to thaw ice on roads in winter   1   **[1]**

(h) **(i)** Reverse osmosis;
flash distillation;
multi-effect distillation;
solar stills
(1 method from the 4 above)   1   **[1]**

(ii) Large volumes of water are needed, so the cost of desalination is too high   1
[1]

[Total: 18]

6 **(a)** Larger box labelled "sugar phosphate backbone" or "chain of deoxyribose and phosphate residues"   1

Smaller box labelled "bases"   1   **[2]**

(b) Quality of written communication

Information is clearly and coherently organised.   1
Specialist vocabulary is used appropriately: base, codon, ribosome, nucleus, RNA   1
Text is legible.   1
Spelling, punctuation, grammar are accurate.   1

Explanation (6 points from following 7)

In the nucleus 1
RNA is assembled   1
with bases in the order which matches the DNA base sequence.   1

A codon is a sequence of three bases. 1

In a ribosome 1
amino acids are assembled into a protein   1
in the order defined by the RNA codons.   1

                                                                            [10]

(c) Populations of insects could be produced   1
which are resistant to the insecticide   1

(Or: the gene for insecticide production could be transferred to weeds   1
which would grow unchecked.)   1   **[2]**

                                                                    [Total: 14]

Oxford Cambridge RSA Examinations

Advanced GCE

SCIENCE

SYNTHESIS OF SCIENTIFIC CONCEPTS **2845**

Specimen Paper

Additional materials:

Answer paper
String or treasury tag
To be brought by candidate: electronic calculator

TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

Section A

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

Section B

Answer **all** questions.

Write your answers on the separate answer paper provided.

If you use more than one sheet of paper, fasten the sheets together.

You may **not** use a Data Book. All necessary data are given as required in the questions.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

You may use an electronic calculator.

You will be awarded marks for the quality of your written communication where an answer requires a piece of extended writing.

The questions in this paper are synoptic in nature. In your answer to each question you are encouraged to show your knowledge and understanding of different areas of science and apply these, and the scientific skills you have learned, to the situations in the questions.

Section A

Answer **all** questions in this section.

Write your answers to this section in the spaces provided in this booklet.

1   The production of ammonia is the essential step in the manufacture of nitrogenous fertilisers.
    The chemical equation for ammonia production is given below. All substances are gases.

$$N_2 + 3H_2 \; ? \; 2NH_3 \qquad \Delta H = -3286 \text{ kJ kg}^{-1}$$

(a) Explain, in terms of how rate and yield of ammonia production are affected by changes in conditions:

   (i) how the pressure used in the process is chosen;

   ....

   ....

   ....

   ....**[4]**

   (ii) how the temperature used in the process is chosen.

   ....

   ....

   ....

   ....**[4]**

(b) In ammonia production, about 20% of the reactant gas is converted to ammonia. This is about half of the maximum yield which could be obtained. Unreacted gas is separated and recycled. The process is carried out in this way in order to produce the greatest mass of ammonia per day.

The table below shows how the maximum yield of ammonia that can be obtained from the reaction depends on temperature and pressure used.

Pressure	Maximum yield of ammonia /%			
10	51	15	4	1
25	64	27	9	3
50	74	40	15	6
100	82	53	25	11
200	89	67	39	18
400	95	80	55	32
600	97	86	66	42
Temperature / °C	200	300	400	500

(i) Select a value of temperature and a value of pressure that would be suitable for ammonia production.

....**[1]**

(ii) Justify your choice of conditions.

....

....**[1]**

[Total: 10]

2   There is evidence to suggest that, as well as using sonar, some marine mammals also make use of background noise present in the oceans to locate underwater objects. This second acoustic technique is analagous to the way in which we, on land, view illuminated objects by sensing the visible light scattered by them.

(a) Explain which of the two acoustic imaging techniques used by marine mammals involves passive sensing, and which active sensing.

....

....

....**[4]**

Just as we can take a photograph of an illuminated object, it should be possible to create a sound image of an underwater object. Indeed, a new technique, called ADONIS, uses a spherical reflector instead of a lens, and an array of underwater microphones to detect background noise scattered by a submerged object. This technique is illustrated by the ray diagram below.
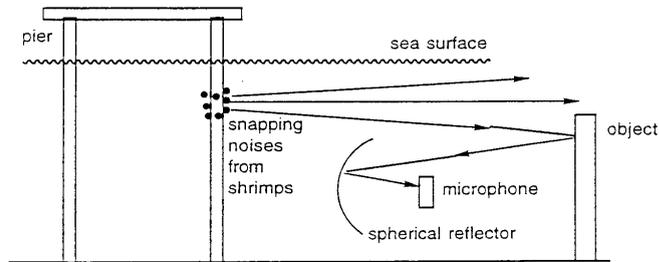
(b) (i) What is the function of the spherical reflector?

....**[1]**

(ii) Which part of a camera plays the same role as the array of underwater microphones?

....**[1]**

(c) Use the information given in the ray diagram to explain how an image of the object is formed.

....

....

....**[3]**

(d) ADONIS is being used to monitor whale populations in the oceans.
Suggest **one** reason why ADONIS is better than sonar for this purpose.

.... **[1]**

[Total: 10]

3 In the past, the relationship between varieties of plants was established by comparing their characteristics. Varieties with similar characteristics were assumed to be closely related; those with different characteristics were assumed to be more distantly related. This method was not always successful. These days, relationships can be more certainly established by DNA analysis.

Explain why analysis of DNA can be used to establish relationships between varieties.
(In this question, 4 marks are available for the quality of written communication.)

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.... **[10]**

[Total: 10]

4 Describe the scientific background to food preservation by irradiation.
(In this question, 4 marks are available for the quality of written communication.)

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....…..…...…......

....….… **[10]**

[Total: 10]

Section B

Answer **all** questions in this section.

Write your answers to this section on sheets of examination paper and attach them securely to this booklet before handing in your answers.

5   In this question 16 marks are given for scientific content and 4 marks for quality of written communication.

Can we crack Europa's icy secrets?

The Galileo spacecraft will spend most of the next year trying to solve the mysteries of Jupiter's ice-glazed moon Europa - which some scientists believe could harbour life. Mission researchers outlined their plans last week in Cambridge Massachusetts, at a meeting of the American Astronomical Society's Division of Planetary Sciences.

When Galileo flew past Europa in April, its images seemed to show ice floes that had partially melted and refroze. "The big question is what's below that", says Clark Chapman, a planetary scientist with the Southwest Research Institute based in Boulder , Colorado.

If liquid ocean lurks beneath the frozen surface, life could have evolved around volcanic vents on the seabed - just as it has on Earth. But probing beneath the frozen surface will have to wait for a proposed Europa Orbiter mission, which could be launched as early as 2002.

Meanwhile, Galileo will fly by Europa eight times. Planetary scientists hope this will help to answer questions such as when Europa's surface last melted and refroze. Estimates vary from a million to two billion years. Scientists hope to get a more accurate figure by counting impact craters in the ice, and studying the build-up of interplanetary dust on the surface.

The above passage is abridged from a short news feature by Jeff Hecht, which first appeared in *New Scientist* on 9 August 1997.

Read the passage carefully, and then use your knowledge of processes on Earth to:

(a)   explain why scientists believe it possible that liquid water lies beneath the ice floes on Europa;   **[6]**

(b)   explain how an ecosystem could develop around volcanic vents on Europa's seabed;   **[6]**

(c)   suggest how scientists might use impact craters in the ice as proxy evidence in determining when Europa's surface last melted and refroze.   **[4]**

[Total: 20]

6   In this question 24 marks are given for scientific content and 6 marks for quality of written communication.

Beach bugs make for a cooler world

Genetically engineered cyanobacteria may soon be used to soak up carbon dioxide from the atmosphere and turn it into a raw material for biodegradable plastic, say Japanese researchers.

Scientists at Japan's National Institute of Bioscience and Human Technology in Tsukuba Science City and the Research Institute of Innovative Technology for the Earth in Kyoto say that they can make the cyanobacterium (*Syenechoccus sp.)* produce up to 10 per cent of its dry body weight as polyhydroxybutyric acid (PHB). Joining PHB in a copolymer with hydroxyvalerate produces a biodegradable plastic. The only raw materials required to produce PHB are water and carbon dioxide.

The Japanese scientists want to use the genetically engineered organism to extract CO_2 from exhaust gases in factories - simultaneously reducing emissions of a greenhouse gas while making a useful product.

The cyanobacteria are usually found on beaches and use light and CO_2 to produce the polysaccharide, glycogen. The researchers have inserted a gene from the bacterium *Alcaligenes eutrophus*, which itself usually produces PHB from hydrogen gas, sugars and water. Inside its new host, the gene uses the cyanobacterium's light and CO_2 pathway, but produces PHB rather than glycogen.

The above text is taken from a short news feature by Peter Hadfield which first appeared in *New Scientist* on 12 July 1997.

Read the text carefully. Then use your knowledge of science to expand the text into a longer article, explaining more fully what the Japanese scientists are doing, and why.

[Total: 30]

Oxford Cambridge and RSA Examinations

Advanced GCE

SCIENCE

SYNTHESIS OF SCIENTIFIC CONCEPTS   **2845**

Mark Scheme

1 **(a)** **(i)** Rate increases with increasing pressure. 1

Yield increases with increasing pressure. 1

Both lead to more ammonia   1
if a high pressure is chosen.   1   **[4]**

(ii) Rate increases with increasing temperature.   1

Yield decreases with increasing temperature.   1

The factors oppose one another / a compromise is needed 1
so a moderate temperature is chosen.   1   **[4]**

(b) **(i)** 400 °C and 600 atm (or 400 °C, 400 atm)   1   **[1]**

(ii) Rate will be fast and yield is not reduced by use of too high a temperature   1 **[1]**

[Total: 10]

2 **(a)** Sonar is an active sensing technique   1
since it involves the transmission   1
of a sound.   1
The second acoustic technique is passive sensing because it only detects incoming sound
waves.   1   **[4]**

(b) **(i)** To focus the background noise on the detector.   1   **[1]**

(ii) The photographic film.   1   **[1]**

(c) The object scatters sound waves coming from the shrimps.   1
Some of these scattered rays fall on the reflector.   1
and are focused onto the array of underwater microphones.   1   **[3]**

(d) Monitoring can take place without disturbing the whales by the use of sonar frequencies.
1   **[1]**

[Total: 10]

3 **Bringing together knowledge, principles and concepts about**

Evolution
•   random mutation occurs in DNA   1
•   leading to individuals with a new characteristic   1
•   this characteristic can be passed on by reproduction   1
•   if the characteristic gives an increased chance of survival, numbers will increase, leading
    eventually to a new variety   1
•   further mutation leads to further variety   1

DNA
- DNA contains a sequence of bases   1
- sequences will be more similar where varieties are more closely related 1
- similarities can be investigated by breaking down DNA and comparing the fragments   1

(6 points from the above 8)   **[6]**

Quality of written communication (4 marks)

- Information is clearly and coherently organised. 1

- Specialist vocabulary is used appropriately: mutation, base sequence, characteristic, variety, DNA. 1

- Text is legible. 1

- Spelling, punctuation, grammar are accurate.   1   **[4]**

[Total: 10]

4   **Bringing together knowledge, principles and concepts about**

Decay and population growth
- micro-organisms / bacteria / fungi / decomposer organisms in food   1
- cause disease / produce toxins / damage the taste or texture of food   1
  grow exponentially from a small initial population   1

Radiation

- ʔ   radiation 1
- has a high penetrating power; so can irradiate all the food sample   1
- kills micro-organisms / damages cells so micro-organisms cannot reproduce   1
- does not leave radioactivity behind in the food   1
  (6 points from the above 7)   **[6]**

  Quality of written communication

- Information is clearly and coherently organised   1

- Specialist vocabulary is used appropriately: 1

- Text is legible   1

- Spelling, punctuation, grammar are accurate   1   **[4]**

[Total: 10]

5 **(a)** Ice floats on water.   1

Ice has a lower density than water.   1

This is a consequence of the structure of ice,   1
which is more open   1
as a result of the directional nature   1
of the hydrogen bonding that exists between water molecules.   1

Ice at the seabed may also be melted as volcanic activity causes heating.   1

(Any 6 points from the list above)   **[6]**

(b) Volcanic activity warms water, so life can exist.   1

No sunlight at the seabed   1
so an alternative form of useful energy must be present.   1

Some organisms are able to use energy from chemical compounds released
from the volcanic vents.   1

Other chemicals released during volcanic activity could be used as nutrients.   1

Under these conditions, suitably evolved producer organisms flourish around
the vents.   1

Other organisms may evolve which consume the producers.   1

(Any 6 points from the list above)   **[6]**

(c) Count the impact craters in a specified area of Europa's surface.   1
Find out how frequently Europa is currently struck by meteorites.   1
Assume that the frequency of impact has been the same throughout Europa's
history.   1
Scale down the frequency to that of the area under study.   1
Work out how long it must have taken for the measured number of impacts to
occur.   1
Currently existing craters must have formed after the last episode of refreezing. 1

(Any 4 points from the list above)   **[4]**

Quality of written communication

Clear and coherent organisation of information   1

Appropriate use of specialist vocabulary   1

Text is legible   1

Correct use of spelling, punctuation and grammar so that meaning is clear   1   **[4]**

[Total: 20]

6 Candidates' articles should include a selection of the following points.

Cyanobacteria:

are commonly called blue-green algae;   1

are single-celled organisms;   1

contain chlorophyll   1
which absorbs and uses light energy of particular wavelengths;   1

convert carbon dioxide and water to glucose by photosynthesis;   1

further convert (or polymerise)   1
the glucose to glycogen.   1

(Any 5 points from the list above)   **[5]**

The cyanobacteria *Syenechoccis sp*. is genetically engineered to produce PHB rather than glycogen:

a gene for PHB production 1
is selected and cut 1
from another bacterium which naturally makes PHB / from *Alcaligenes eutrophus*;   1

a plasmid   1
from the host bacterium (or organism)   1
is cut open   1
using a restriction enzyme; 1

the selected gene is spliced into the plasmid   1
using ligase enzymes;   1

the plasmid is reabsorbed back into the host   1
by suspending both host and plasmid in a suitable medium. 1

(Any 7 points from the above list)   **[7]**

The PHB made by the genetically engineered cyanobacteria can be manufactured into a biodegradable plastic:

polymerisation is the process in which large molecules are built up from large numbers of smaller ones 1
called monomers; 1

co-polymers contain two different monomers;   1

the monomer PHB can be made to co-polymerise with another monomer, hydroxyvalerate; 1

the co-polymer is decomposed with relative ease by natural processes (since the copolymer is a
    polyester probably, in this case, bacterial processes),   1
thus reducing its environmental impact.   1

(Any 5 points from the above list)   **[5]**

**The environmental relevance of this new process is that the genetically engineered
bacterium could be used to extract carbon dioxide from exhaust gases in factories:**

it is feared that increased levels of carbon dioxide produced by human activity are contributing to
global warming;   1

incoming visible radiation from the Sun passes through the atmosphere   1
and is absorbed by materials on the surface of the Earth,   1
resulting in heating;   1

the Earth's warm surface then emits infrared radiation   1
which is absorbed by certain gases in the atmosphere;   1

carbon dioxide is among the gases that absorb infrared radiation - a greenhouse gas; 1

the PHB monomer produced is made only from carbon dioxide and water;   1

PHB can be made into a useful product which is biodegradable.   1

(Any 7 points from the list above)   **[7]**

Quality of communication

Appropriate form for article: eg divided into sections or with subheads   1

Style appropriate to an article   1

Clear and coherent organisation of information   1

Correct use of specialist vocabulary   1

Legibility of text   1

Correct use of spelling, punctuation and grammar so that meaning is clear   1   **[6]**

    [Total: 30]

Oxford Cambridge RSA Examinations

Advanced GCE

SCIENCE

SCIENCE AND GLOBAL PROCESSES   **2846/01**

Specimen Paper

Candidates answer on the question paper

Additional materials:
> To be brought by candidate: electronic calculator

TIME 1 hour

INSTRUCTIONS TO CANDIDATES

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

You may **not** use a Data Book. All necessary data are given as required in the questions.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

You may use an electronic calculator.

1 In the North Sea, the tidal movement approximates to simple harmonic motion with an amplitude of about 3 m at spring tides and about 1 m at neap tides.

Table 1 shows sea levels at high and low tide in Hartlepool Bay (off the N. E. coast of England) in April, 1998. A sea level of 0.00 m corresponds to the lowest tide that is likely.

Table 1

Date	Time	Sea level / m
April 26	03-09	5.51
	09-25	0.61
	15-22	5.62
	21-51	0.30
April 27	03-54	5.62
	10-10	0.47
	16-09	5.71
	22-35	0.32
April 28	04-37	5.62
	10-55	0.45
	16-56	5.66
	23-19	0.47

(a) **(i)** On what date was there a spring tide in Hartlepool Bay?

....**[1]**

(ii) Suggest **one** date on which there would have been a neap tide.

....**[1]**

(b) Explain how the data in Table 1 support the statement that tidal movement in the North Sea has an amplitude of about 3 m at spring tides.

....

....

....**[2]**

(c) Explain what is meant by simple harmonic motion.

....

....

....

....**[3]**

(d) Simple harmonic motion can be described by the equation: $x = A \cos 2\pi ft$
(where x is the displacement, A is the amplitude, t represents time, and $1/2\pi f$ is the period of oscillation).

(i) Sketch a cosine function using the axes provided below.

displacement

time
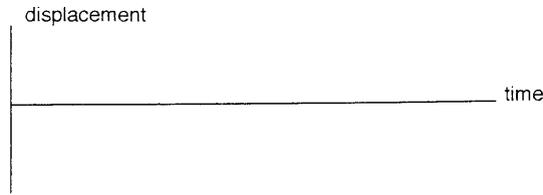
[1]

(ii) In terms of amplitude and period of oscillation, explain how tidal movement in the North Sea **approximates** to simple harmonic motion. Use data from Table 1 to illustrate your answer.

....

....

....

....**[3]**

(e) A power boat leaves Hartlepool Marina at a speed of 2 m s^{-1}. Once it is in Hartlepool Bay, the speed of the boat is increased, under constant acceleration for 5 s, from 2 m s^{-1} to a top speed of 16 m s^{-1}. The boat then races at its top speed for a further 125 s to reach Longscar Bell (a marker buoy out at sea).

(i) Calculate the acceleration of the power boat.

....

....**[2]**

(ii) Calculate the distance travelled by the power boat while it was accelerating.
Use the equation: $v^2 = u^2 + 2as$
(where *v* and *u* represent speed, *a* is acceleration, and *s* represents distance).

....

....**[2]**

(iii) Calculate the distance travelled by the power boat from leaving Hartlepool Marina to reaching Longscar Bell.

....

....**[2]**

[Total : 18]

2 Scientists have suspected for some time that the Indo-Australian tectonic plate had broken in half as a result of pushing against the Eurasian plate: a process which has led to the formation of the Himalayan mountains. Evidence has now been obtained, using seismic surveying, that this is indeed the case, and that the two halves are behaving like separate plates. The evidence suggests that the process of splitting probably began about 8 million years ago.

(a) Draw a labelled diagram to illustrate the layered structure of the Earth. Indicate on your diagram a region which could behave as a tectonic plate.

[5]

(b) Which two tectonic plates are involved in the formation of the Himalayas?

....**[1]**

(c) Explain how plate tectonic theory explains the formation of a mountain range, such as the Himalayas.

....

....

....

....**[3]**

(d) Name and describe, in outline, one technique (other than seismic surveying) which has been used to provide evidence for plate tectonic theory.

....

....

....**[3]**

[Total: 12]

3 Chlorine is present in the sea in the form of ionic chlorine compounds such as sodium chloride (NaCl). The action of some marine organisms (eg: some bacteria and algae) convert chloride ions into chlorine-containing molecules such as chloromethane (CH_3Cl). Molecular chlorine-containing compounds are more volatile and less soluble in water than ionic compounds, and contribute significantly to the transfer of chlorine from the oceans to the atmosphere.

Data about sodium chloride and chloromethane are given in the table below.

property	sodium chloride	chloromethane
structure	ionic	molecular
melting point /K	1074	176
boiling point /K	1686	249
solubility in water	good	poor

Electronegativity values (symbolised by the Greek letter χ) for sodium, hydrogen, carbon and chlorine are as follows: $\chi_{Na} = 0.9, \chi_H = 2.1, \chi_C = 2.5, \chi_{Cl} = 3.0$.

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

....

....**[2]**

(b) The structure of a chloromethane molecule is

$$H - \underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}} - Cl$$
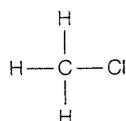
Use the electronegativity values given to predict the polarity of a C-Cl bond.
Represent this on the structure above. **[2]**

(c) In liquid and gaseous chloromethane, most of the intermolecular bonding arises from dipole-induced dipole bonding rather than from dipole-dipole bonding. Explain why.

....

....

....**[3]**

(d) Explain, in terms of bonding between molecules or between ions, why the boiling point of chloromethane is lower than that of sodium chloride.

....

....

....

....

....

....

....

....

....

....**[4]**

[Total: 11]

4 **(a)** Ice floats on water because ice is less dense. The presence of hydrogen bonding between water molecules gives ice a relatively open structure which leads to its low density. Describe how this intermolecular hydrogen bonding arises.

....

....

....

....**[3]**

(b) Ice is brittle. Metals are tough.

  (i) Name the type of structure found in

   ice ……………………………   **metals** ………………………………   **[2]**

(ii) Draw a labelled diagram to show the structure and bonding of a metal.

[3]

(iii) Explain why metals are tough.

....

....

....**[2]**

[Total: 10]

5   The North Atlantic Drift current flows from SW to NE in the North Atlantic and is part of the ocean surface to deep water circulation system. It keeps temperatures in the UK and in Scandinavia about 7°C higher than they would otherwise be. The current sinks near northern Scandinavia (above 60°N) because its water has a greater salinity, and therefore a higher density, than the surrounding seawater.

(a)   Add suitable arrows and labels to the map below to show the ocean surface to deep water circulation system.
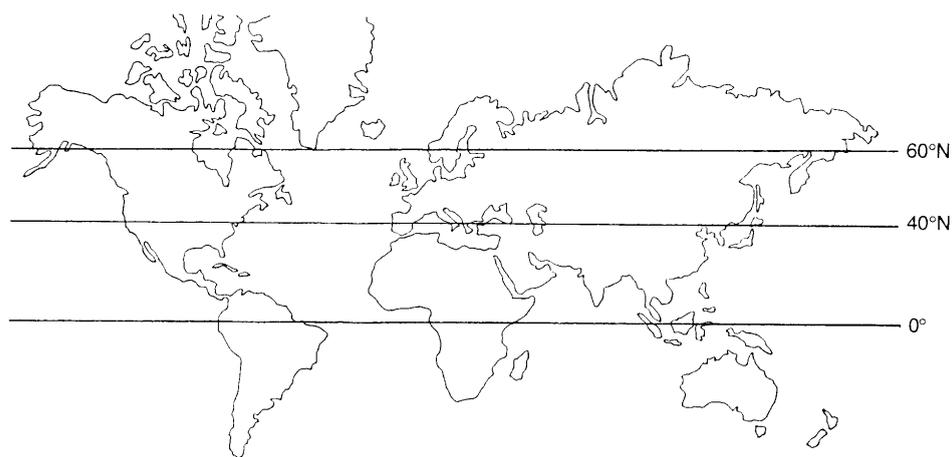
[4]

(b) Explain why water in the North Atlantic Drift has a greater salinity than the seawater near northern Scandinavia.

....

....**[2]**

(c) At the end of the Ice Age, the ice sheet that had covered much of North America melted. There is evidence that the huge volume of fresh water that was produced flowed into the North Atlantic between 40°N and 60°N.

  (i) What effect would this have had on the flow of the North Atlantic Drift?

  ....

  ....**[2]**

  (ii) What is likely to have happened to the climate in the UK and Scandinavia at the end of the Ice Age?

  ....

  ....**[1]**

[Total: 9]

Oxford Cambridge and RSA Examinations

RECOGNISING ACHIEVEMENT

Advanced GCE

SCIENCE

SCIENCE AND GLOBAL PROCESSES   **2846/01**

Mark Scheme

1 **(a)** **(i)** April 27 1
    (ii) April 20 / May 4 (answer $\pm$ 1 day)   1   **[2]**

(b) Amplitude is $^1/_2$ difference between maximum and minimum sea levels.   1
    Value is 2.7 m at spring tide quoted   1   **[2]**

(c) Motion in which the **acceleration**   1
    is **proportional** to the **displacement** from a fixed point   1
    and in the **opposite direction** to the displacement   1

    Or: motion where position oscillates between limits   1
    changing rapidly in the middle of the range   1
    slowing down then stopping at the ends of the range)   1   **[3]**

(d) **(i)** For correctly shaped cosine function starting at maximum displacement   1 **[1]**

    (ii) Amplitude is not constant   1
        high tide levels vary between 5.51 and 5.71 m / spring tides 3 m,
        neap tides 1 m   1

        The period is variable   1
        there seem to be two periods : 12h 15 min and 12 h 30 min   1   **[4]**

(e) **(i)** v = u + at   1
        a = 2.8 m s^{-2} 1   **[2]**

    (ii) Correct value of $v^2 - u^2$, ie. 252 m^2 s^{-2} 1
        correct value of s, ie. 45 m   1   **[2]**

    (iii) Distance travelled at top speed = 16 m s^{-1} x 125 s = 2000 m   1
        distance to Longscar = 2045 m. 1   **[2]**

[Total: 18]

2 **(a)** Diagram to show (from centre):
    core 1
    mesophere   1
    asthenosphere1
    and lithosphere   1
    Lithosphere identified as region of plates.   1

    (Alternatively, diagram to show: core mantle and crust,   3
    with crust and outer mantle identified as region of plates)   2   **[5]**

(b) Indo-Australian plate and Eurasian plate.   1   **[1]**

(c) Two plates collide.   1
    Offshore sediments   1
    are pushed up to form mountains   1   **[3]**

(d) Either: palaeomagnetism: 1
data from mid-oceanic ridges show   1
magnetism matches on each side of ridge.   1

Or: analysis of ocean floor: 1
sediments have been dated,   1
none are older than the Cretaceous (or 200 million years) (or they are all young rocks).   1

[3]

[Total: 12]

3 **(a)** Electronegativity is a measure of the power of atoms which are bonded 1
to become negatively charged (or: to draw electron density to themselves).   1   **[2]**

(b) Use of $\delta+$ and $\delta-$ symbols   1
Negative charge on chlorine and positive charge on carbon   1   **[2]**

(c) Molecules are moving randomly in liquid and vapour. 1
The dipoles on adjacent molecules therefore cannot line up to interact. 1
A dipole can induce a dipole whatever the orientation of the molecules.   1   **[3]**

(d) Awareness that particles separate on boiling (1 mark)
Eg: Molecules or ions have to move apart during boiling.   1

Comparison of strengths of bonding between two types of particle (1 mark)
Eg: Dipole-induced dipole bonding is weak. Ion-ion bonding is strong. 1

Comparison of accompanying energy changes (1 mark)
Eg: Less energy is needed for this in chloromethane   1

Link between energy change and temperature (1 mark)
Eg: The necessary energy change is achieved at a lower temperature for
chloromethane   1   **[4]**

[Total: 11]

4 **(a)** H atoms in H_2O have a $\delta+$ charge   1
a lone pair is donated to an H 1
from an O of a neighbouring molecule   1   **[3]**

(b) **(i)** ice : molecular   1
metal : metallic   1   **[2]**

(ii) Diagram to show:
lattice of particles (as circles)   1
labelled as positive ions / cations 1
with 'sea' of electrons in between   1   **[3]**

(iii) Layers of ions slip along when the shape of a metal is changed   1
the new arrangement bonds as well as before   1   **[2]**

[Total: 10]

5 **(a)** Arrows and labels to show:
sinking water in the N Atlantic and in the S Atlantic, east of S. America   1
upwelling in the Indian Ocean and central Pacific Ocean   1
surface current E to W from upwelling, round S Africa, then S to N in Atlantic   1
deep water current N to S in Atlantic, round S Africa, then W to E into Indian and Pacific
Oceans   1   **[4]**

     (b) Water flows from warmer seas / Caribbean   1
undergoes more evaporation than colder water near Scandinavia   1   **[2]**

     (c)   **(i)** Water would sink further south   1
the current would not flow so far north   1   **[2]**

       (ii) It would stay cold because the warming effect of the current would be lost   1
                                                                          [1]

                                                                   [Total: 9]