

**Advanced Subsidiary GCE  
SCIENCE**

## G641 QP

Unit G641: Sensing and the Natural Environment

**Specimen Paper**

Candidates answer on the question paper.

Time: 1 hour

Additional Materials:

Electronic calculator

Candidate  
Name

Centre  
Number

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Candidate  
Number

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**INSTRUCTIONS TO CANDIDATES**

- Write your name, Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED.

**INFORMATION FOR CANDIDATES**

- The number of marks is given in brackets [] at the end of each question or part question.
-  Where you see this icon you will be awarded marks for the quality of written communication in your answer.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	14	
2	13	
3	12	
4	10	
5	11	
<b>TOTAL</b>	<b>60</b>	

This document consists of **14** printed pages and **2** blank pages.

Answer **all** the questions.

1 This question is about the properties of waves.

Fig. 1.1 shows the peaks of water ripples spreading from a point and meeting a barrier with a gap, so that diffraction is taking place. The direction of travel of waves is also indicated by a single ray.

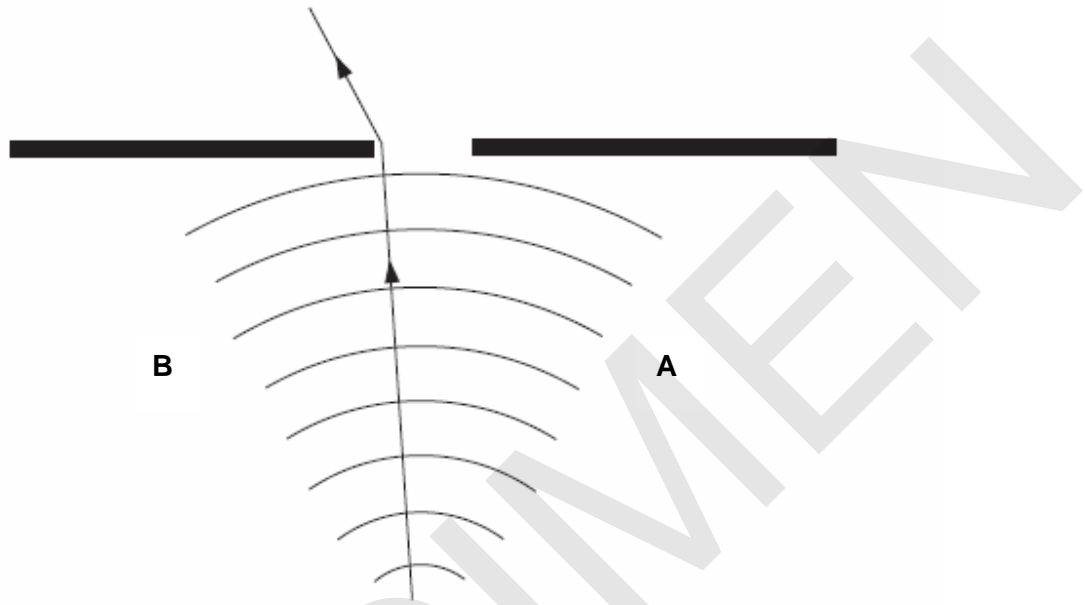


Fig. 1.1

(a) On Fig. 1.1

- (i) label one wavelength; [1]
- (ii) draw suitable lines to show the peaks of diffracted waves which would be observed after passing through the gap; [1]
- (iii) draw **two** further rays which show the direction of travel of the waves at point **A** and point **B**. [1]

(b) All types of electromagnetic radiation experience diffraction.

What does this indicate about the radiation?

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

(c)

- (i) Use the idea of **reflection** of electromagnetic radiation to explain how a picture on a piece of paper is detected by the human eye.

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

- (ii) Use the idea of **refraction** of electromagnetic radiation to explain how the human eye produces an image of the picture

 *In your answer, you should use appropriate technical terms, spelled correctly.*

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

- (iii) Explain why effects involving diffraction of visible light are relatively difficult to detect.

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

- (iv) The resolution of some optical instruments are limited by diffraction. Give an example of such an instrument and explain why its resolution is likely to be limited

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

[Total: 14]

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- 2 The Sun and the Earth emit electromagnetic radiation in different regions of the spectrum. Fig. 2.1 shows emission spectra of the Sun and the Earth.

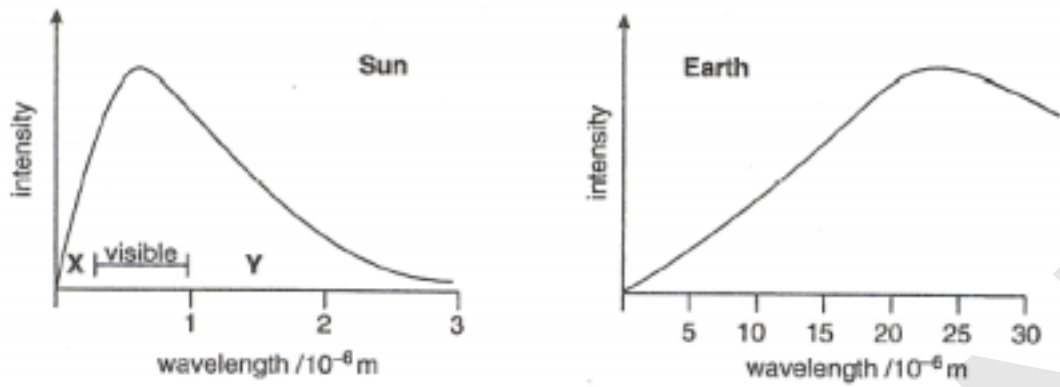


Fig 2.1

- (a) The wavelength of electromagnetic radiation emitted from the Sun is shorter than that emitted from the Earth. Explain why.

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

- (b) Name the regions of the spectrum shown as X and Y on the emission spectrum of the Sun in Fig. 2.1.

X is .....

Y is ..... [2]

- (c) The Meteosat satellite provides information about weather patterns on the Earth. Two of the channels of the electromagnetic radiation sensed by the satellite are:

Channel 1	$0.4 \times 10^{-6} \text{ m}$ to $1.1 \times 10^{-6} \text{ m}$	mainly visible light
Channel 2	$5.7 \times 10^{-6} \text{ m}$ to $7.1 \times 10^{-6} \text{ m}$	thermal infrared radiation

Use Fig. 2.1 to suggest the source of the electromagnetic radiation in these two Meteosat channels:

Channel 1: .....

Channel 2: ..... [1]

- (d) Fig. 2.2 shows the intensity of the electromagnetic radiation that reaches Meteosat from the Earth. Some wavelengths are absorbed by gases in the Earth's atmosphere. Some gases responsible for these absorptions are shown in Fig. 2.2.

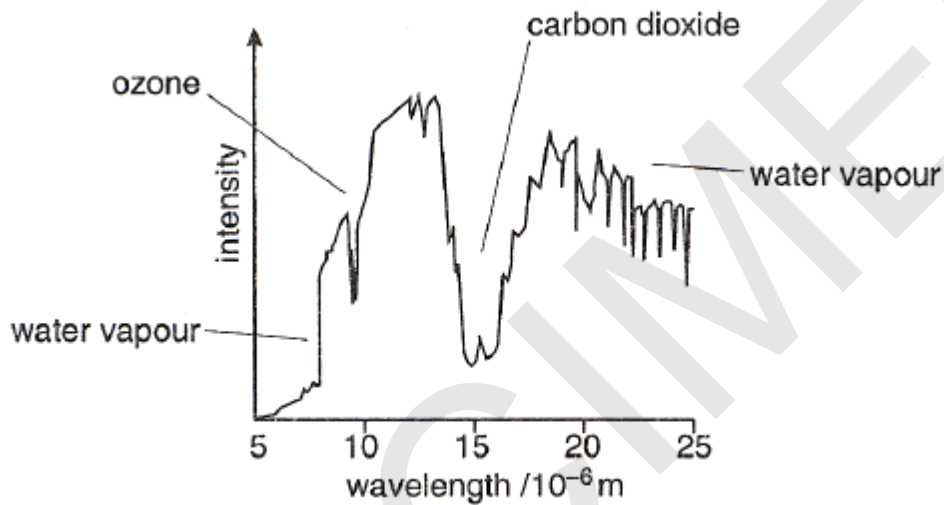


Fig. 2.2

Suggest why the range  $5.7 \times 10^{-6} \text{ m}$  to  $7.1 \times 10^{-6} \text{ m}$  is chosen for the study of weather patterns.

.....

.....

..... [2]

- (e) Fig. 2.3 opposite shows the area around Mount Everest, produced using radar (upper image) and visible light (lower image).

Compare and contrast the images in terms of types of radiation used, methods used and features shown.

You may wish to address the following points in your answer.

- The differences and similarities between the two types of radiation
- The differences and similarities in the features visible on the images
- The way in which the two types of radiation interacts with the features

 In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

.....

.....

.....

.....

.....

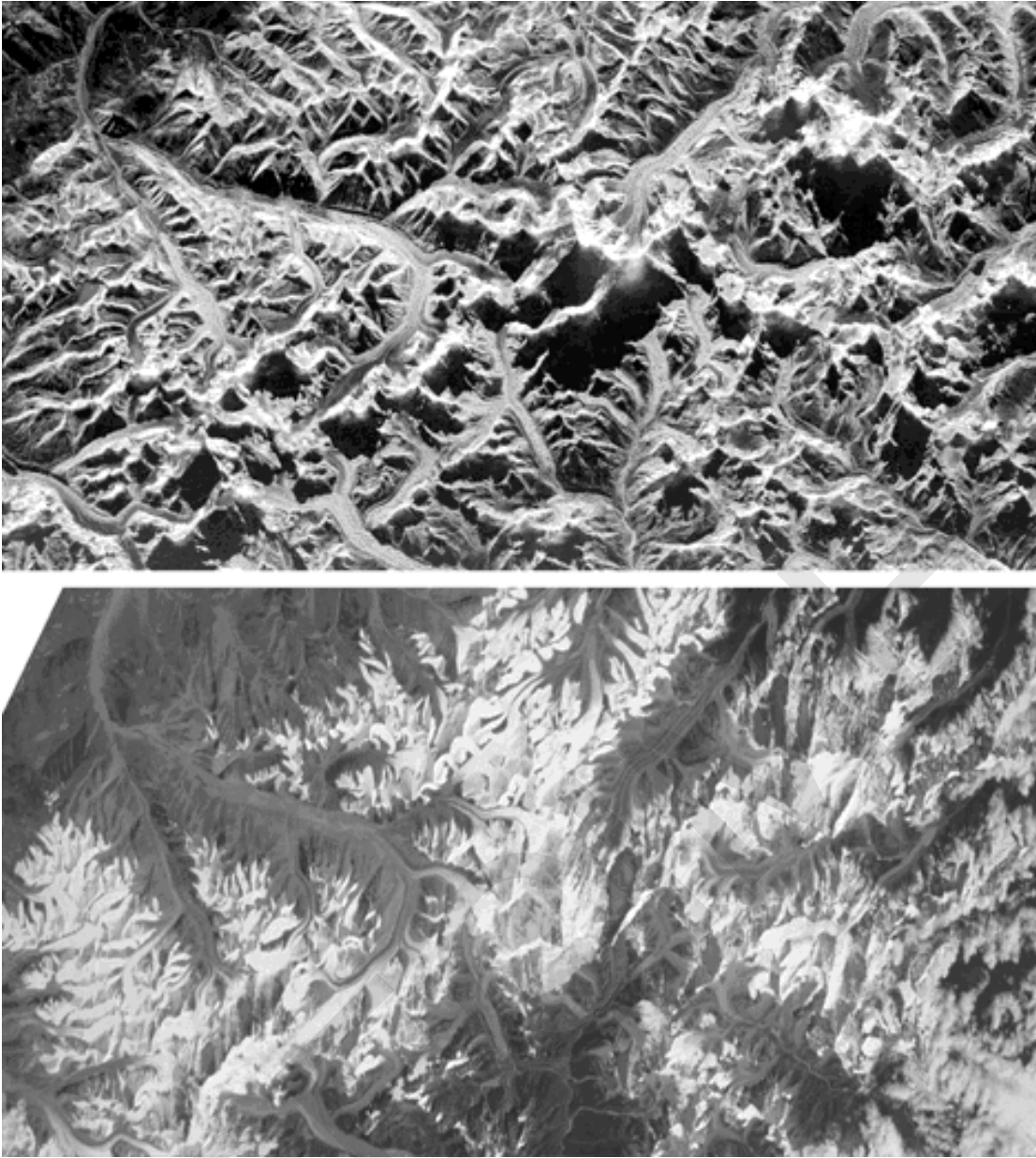
.....

.....

.....

..... [7]

[Total: 13]



**Fig. 2.3** courtesy of NASA/JPL Caltech © 2007

[Turn over

3 This question is about some of the chemical processes which occur in cells.

(a) Explain what is meant by each of the following terms.

(i) *respiration*

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

(ii) *biosynthesis*

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

(iii) *active transport*

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

(b) Fig. 3.1 shows how energy stored in a cell may be used. Some of the energy is converted to an alternative form and some of it is converted into a less useful form.

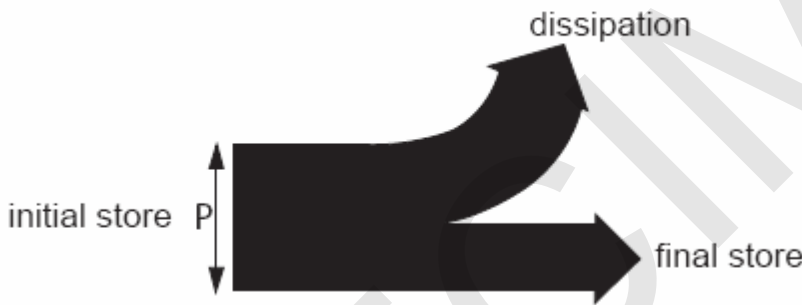


Fig. 3.1

(i) Describe one way in which energy can be stored in a cell.

..... [2]

(ii) Give an example of a “less useful form of energy” which may be produced from stored energy in a cell.

..... [1]

(iii) Which two processes mentioned in (a) are involved in Fig. 3.1? Explain your answer.

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

[Total: 12]



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**[Turn over**

4 Some insect species have become resistant to insecticides. The data in Fig. 4.1 show how the number of insect species resistant to insecticides changed from 1955 to 1975.

year	number of insect species resistant to insecticides
1955	37
1958	79
1963	160
1968	226
1975	364

Fig 4.1

(a) Plot these data on the grid in Fig. 4.2.

Draw a line of best fit to show the pattern in the data.

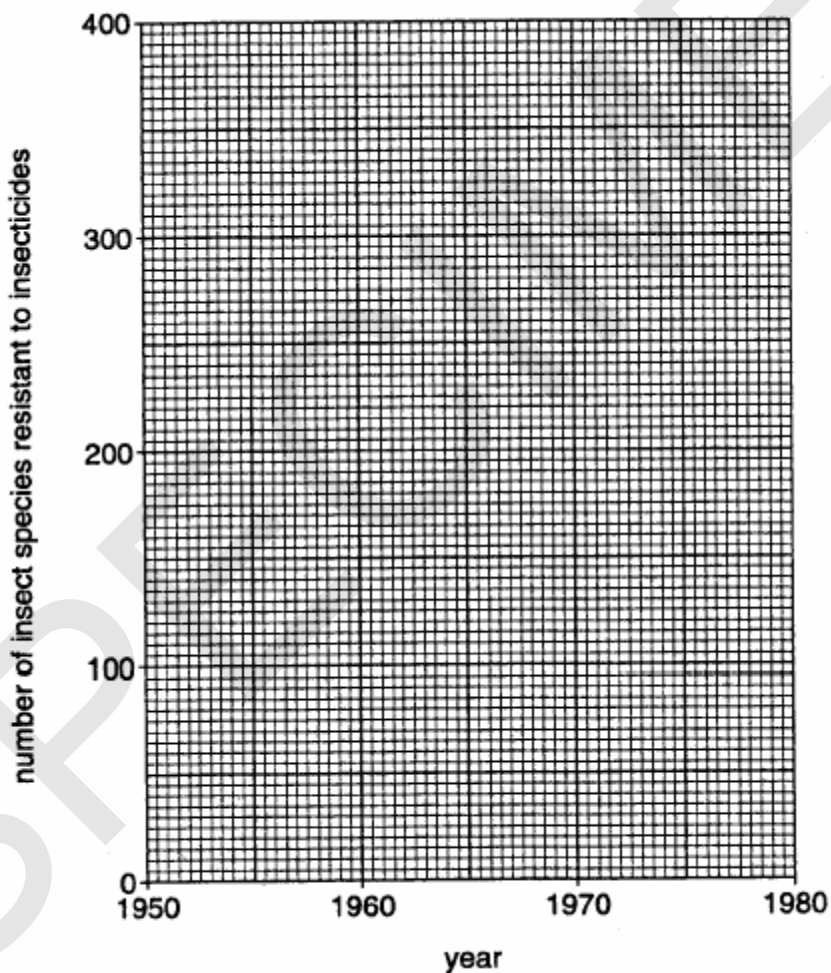


Fig 4.2

[2]

(b) Use the graph to calculate the average annual rate of increase of insect resistant species, in terms of number of species per year.

Annual rate of increase = ..... species per year

[2]

- (c) Adaptation and speciation are two terms which are used to describe changes in populations of organisms.

Which term, adaptation or speciation, best describes the development of insecticide-resistant species in the study? Explain your answer.

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

- (d) Give a different example of how human activity has caused a change in another species, and explain how this change has occurred.

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

[Total: 10]

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5 Calcium is an important nutrient element in ecosystems. Fig. 5.1 illustrates a calcium cycle in a woodland ecosystem.

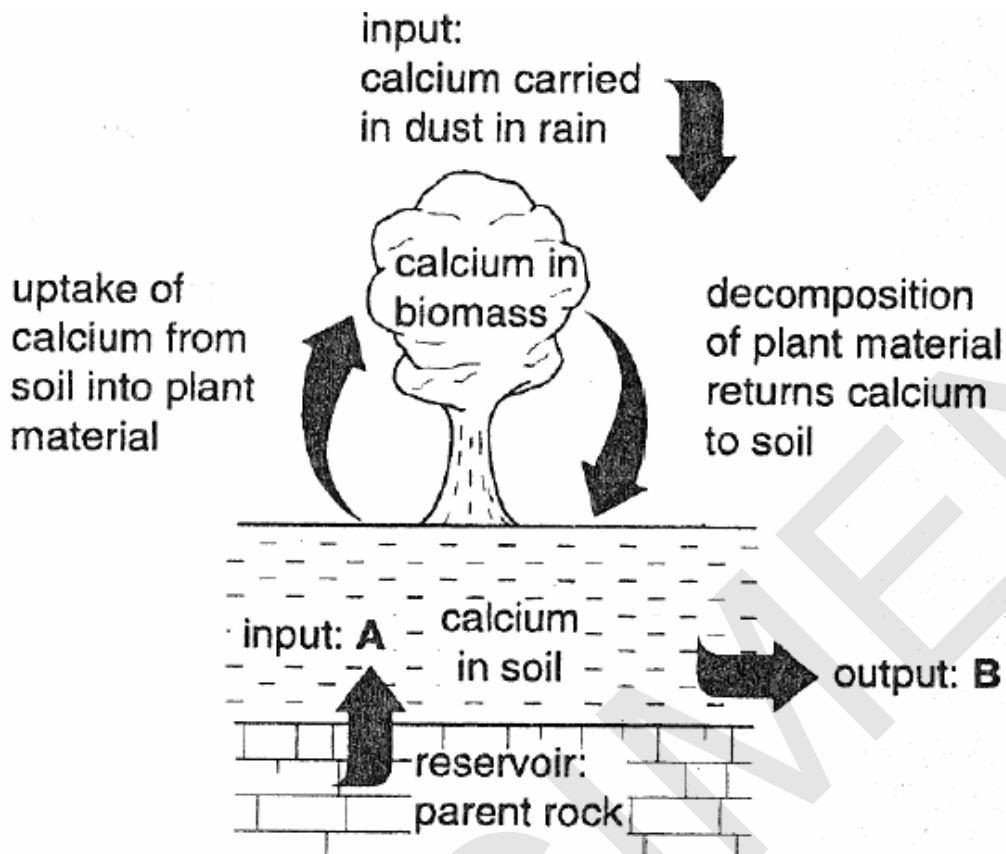


Fig. 5.1

(a) Name the processes labelled **A** and **B**.

A: .....

B: ..... [2]

(b) A climax ecosystem is one in which the quantity of each nutrient element does not change from year to year.

An investigation of a climax woodland ecosystem showed that, in one year, process **A** added 1.1 kg of calcium per hectare, and 3.9 kg of calcium per hectare was lost by process **B**.

Use the data to calculate the mass of calcium per hectare that entered the ecosystem in rain.

answer = ..... kg per hectare [1]

(c) Name **one other** nutrient element that is cycled in an ecosystem.

..... [1]

- (d) Deforestation often causes the output of nutrients, such as calcium, to increase.

Explain why deforestation could have this effect

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

- (e) Nutrient levels in an undisturbed ecosystem are maintained in a steady state. Felling trees upsets the steady state. As a result, negative feedback mechanisms operate to establish a new steady state.

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

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

(ii) Describe **one** feedback mechanism that would reduce the loss of calcium from an area of cleared forest.

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

[Total: 11]

Paper Total [60]

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*Copyright Acknowledgements:*

*Sources*

**Fig. 2.3:** Courtesy of NASA/JPL Caltech © 2007

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The maximum mark for this paper is **60**.

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Question Number	Answer	Max Mark
<p><b>1(a)(i)</b></p> <p><b>(ii)</b></p> <p><b>(iii)</b></p> <p><b>(b)</b></p> <p><b>(c)(i)</b></p> <p><b>(ii)</b></p> <p><b>(iii)</b></p> <p><b>(iv)</b></p>	<p>any wavelength drawn and labelled;</p> <p>circular waves spreading from gap;</p> <p>Direction of rays shows spreading <b>and</b> both rays drawn perpendicular to waves;</p> <p>Electromagnetic radiation is in the form of waves;</p> <p>Diffraction is only observed for waves;</p> <p>light from a <u>source</u> is reflected;</p> <p>reflection is different at different points in the pattern;</p> <p>reflection is diffuse / some scattering occurs;</p> <p>Focussing occurs;</p> <p>Caused by refraction at (surface of) lens / cornea;</p> <p>Refraction is a change in direction of light;</p> <p>Caused by change in density AW change in speed of the light ;</p> <p>Any two points</p> <p>one of the terms: cornea / focus/ focussing to be included and spelt correctly.</p> <p>diffraction only occurs when wavelength is similar size to object;</p> <p>wavelength for visible light is very small / only occurs for small objects;</p> <p>microscopes ;</p> <p>are used with small objects;</p>	<p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[1]</p> <p>[2]</p> <p>[3]</p> <p>[2]</p> <p>[2]</p> <p>[2]</p>
		[14]
<p><b>2(a)</b></p> <p><b>(b)</b></p> <p><b>(c)</b></p> <p><b>(d)</b></p>	<p>Sun is hotter than the Earth;</p> <p>X: ultra violet / UV;</p> <p>Y: infrared;</p> <p>Channel 1: Sun and Channel 2: Earth;</p> <p>Allows detection of water vapour;</p> <p>Water vapour absorbs at those wavelengths;</p>	<p>[1]</p> <p>[2]</p> <p>[1]</p> <p>[2]</p>

Question Number	Answer	Max Mark
(e)	Differences: (in technique) A. radar uses <b>radio waves</b> (not visible light); B. <b>wavelength</b> of radio waves is longer than for visible light(ora) AW <b>frequency</b> of radio waves is lower; C. radio/radar waves' source is associated with the detector/satellite; visible waves' source is the Sun (in features visible) D. snow (white patches) show only on visible image; E (shadows of) mountains/relief shows up more clearly on radar image Similarities (in technique) F. both use a form of electromagnetic radiation;  G. both types of radiation <b>reflect</b> off surface; H: Both show rivers / glaciers / valley floor; One of the terms: wavelength/frequency / electromagnetic / to be included and spelt correctly.	[7]
		[13]
3(a)(i)	production of energy / ATP (from storage); glucose and oxygen react;	[2]
(ii)	production of large molecules; from smaller components/raw materials; AW gives example (e.g. proteins from amino acids);	[2]
(iii)	movement of material in/out of cells; against concentration gradient AW requiring energy transfer/supply	[2]
(b)(i)	As chemical energy; In the form of biomass / glucose / starch / glycogen / fat;	[2]
(ii)	heat / thermal energy	[1]
(iii)	Respiration <b>and</b> biosynthesis Respiration transfers energy from stored to heat which is dissipated biosynthesis transfers energy into a stored form	[3]
		[12]
4(a)	4 points correctly plotted best fit line drawn	[1] [1]
(b)	gradient used correct value	[1] [1]
(c)	(adaptation) population/species has <b>changed</b> in response to changing environment / But population is not isolated; timescale is too short for a new species to emerge;	[3]

Question Number	Answer	Max Mark
(d)	any valid example; appropriate human activity causing environmental change; description of change in species / selection e.g. antibiotic resistant bacteria; overuse of antibiotics; only bacteria with resistance will survive	[3]
		[10]
5(a)  (b)  (c)  (d)  (e)(i)  (ii)	A: weathering B: leaching 2.8 kg ha <sup>-1</sup> Nitrogen, phosphorous, iron, magnesium, potassium Loss of roots / root mat means that soil is looser Soil is more easily washed away AW increased runoff +1 of more rain reaches soil OR more leaching may also occur a process occurs which opposes a change; by reducing the process causing the change e.g. new trees / plants grow; remove calcium from soil which reduces leaching AW stabilises soil reduces run-off AW prevents rain reaching forest floor reducing leaching / run-off <i>Any other suitable mechanism named (for 1 mark)</i> <i>Described (for 2 marks)</i>	[1] [1] [1] [1]  [3]  [2]  [2]
		[11]
	<b>Paper Total</b>	<b>[60]</b>

## Assessment Objectives Grid (includes QWC)

Question	AO1	AO2	AO3	Total
1(a)(i)		1		1
1(a)(ii)		1		1
1(a)(iii)		1		1
1(b)	2			2
1(c)(i)	1	1		2
1(c)(ii)	1	2		3
1(c)(iii)	2			2
1(c)(iv)	2			2
2(a)	1			1
2(b)		2		2
2(c)		1		1
2(d)		2		2
2(e)	2	5		7
3(a)(i)	2			2
3(a)(ii)	2			2
3(a)(iii)	2			2
3(b)(i)	2			2
3(b)(ii)	1			1
3(b)(iii)		3		3
4(a)			2	2
4(b)			2	2
4(c)	1	2		3
4(d)	3			3
5(a)		2		2
5(b)		1		1
5(c)	1			1
5(d)	1	2		3
5(e)(i)	2			2
5(e)(ii)		2		2
<b>Totals</b>	<b>28</b>	<b>28</b>	<b>4</b>	<b>60</b>

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