OCR
RECOGNISING ACHIEVEMENT

SPECIMEN H

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE **A141/02**

SCIENCE A

Unit A141: Modules B1, C1, P1 (Higher Tier)

Candidates answer on the question paper
A calculator may be used for this paper

OCR Supplied Materials:
None

Other Materials Required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- Your quality of written communication is assessed in questions marked with a pencil (✐).
- A list of useful relationships is included on page 2.
- The number of marks for each question is given in brackets **[ ]** at the end of the question or part question.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.

	For Examiner's Use	
	Max	**Mark**
1	10	
2	9	
3	10	
4	6	
5	4	
6	6	
7	5	
8	7	
9	3	
TOTAL	60	

Turn over

TWENTY FIRST CENTURY SCIENCE DATA SHEET

Useful Relationships

The Earth in the Universe

distance = wave speed x time

wave speed = frequency x wavelength

Sustainable Energy

energy transferred = power x time

power = voltage x current

$$efficiency = \frac{energy\ usefully\ transferred}{total\ energy\ supplied} \times 100\%$$

Explaining Motion

$$speed = \frac{distance\ travelled}{time\ taken}$$

$$acceleration = \frac{change\ in\ velocity}{time\ taken}$$

momentum = mass x velocity

change of momentum = resultant force x time for which it acts

work done by a force = force x distance moved in the direction of the force

amount of energy transferred = work done

change in gravitational potential energy = weight x vertical height difference

$$kinetic\ energy = \frac{1}{2} \times mass \times [velocity]^2$$

Electric Circuits

power = voltage x current

$$resistance = \frac{voltage}{current}$$

$$\frac{voltage\ across\ primary\ coil}{voltage\ across\ secondary\ coil} = \frac{number\ of\ turns\ in\ primary\ coil}{number\ of\ turns\ in\ secondary\ coil}$$

Radioactive Materials

energy = mass x [speed of light in a vacuum]^2

SPECIMEN

Answer **all** the questions.

1 Scientists think embryonic stem cells could be used to treat some illnesses for which there is currently no cure.

(a) Complete the sentences about stem cells.

Embryonic stem cells can develop into any kind of cell. Therefore, stem cells are

described as ....

During development of multi-cellular organisms, stem cells become

....

[2]

(b) Therapeutic cloning has been used to produce stem cells for the treatment of some disorders.

The flow chart illustrates the processes involved in therapeutic cloning.

Use the words provided to complete the flow chart.

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

adult   donor   egg   embryonic   patient   nucleus

An egg cell from a donor

has the ....

removed.

A nucleus is taken from an adult

body cell of the

....

These are combined and given

an electric shock.

A mass of ……………………

stem cells is produced. The

cells are genetically identical to

the ……………………………... .

[2]

(c) The use of human embryos to produce stem cells has caused a lot of arguments and discussion.

Some people think that using stem cells from human **adults** would cause fewer arguments.

Discuss how using adult stem cells differs from using embryonic stem cells and why this might cause fewer arguments.

🖉 *The quality of written communication will be assessed in your answer to this question.*

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....

....**[6]**

[Total: 10]

2 Read the information about phenylketonuria (PKU).

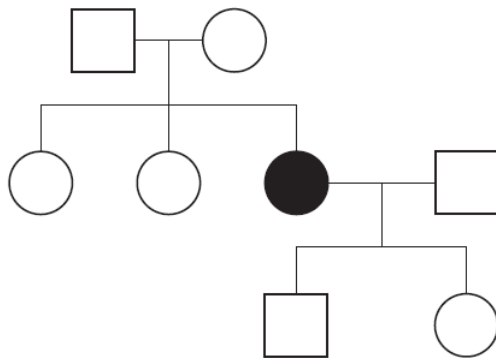PKU is an inherited disorder.

PKU is caused by a faulty gene.

A chemical called phenylalanine builds up in the bodies of people with PKU.

Too much phenylalanine causes serious health problems.

Serious health problems can be avoided with a controlled diet. The sooner this is started after birth, the less harm is caused.

(a) Look at the family tree.

☐ = male without PKU

■ = male with PKU

○ = female without PKU

● = female with PKU

Draw straight lines to link the correct **description** of the inheritance of PKU with the **two** correct **explanations.**

You should join **one** description with **two** explanations.

description

PKU is inherited in a similar way to cystic fibrosis.

PKU is inherited in a similar way to Huntington's disease.

PKU is inherited in a different way from cystic fibrosis and Huntington's disease.

explanation

Parents can be carriers of PKU.

PKU is caused by a dominant allele.

Parents cannot be carriers of PKU.

PKU is caused by a recessive allele.

[2]

(b) Use the example of PKU to describe the difference between an individual's genotype and his or her phenotype.

....

....

....

....**[2]**

(c) Doctors estimate that between 1 in 10 000 and 1 in 12 000 babies born in the UK has PKU.

The Office for National Statistics reported that 710 000 babies were born in the UK in 2008.

(i) Estimate the lower and upper limits for the number of babies born in the UK in 2008 that you would expect to have PKU.

Show your working.

from .... to .... **[1]**

(ii) Testing a baby for PKU costs the NHS £6.

Estimate the upper and lower limits of the cost to the NHS of identifying one baby with PKU.

Show your working.

from £......................... to .... **[1]**

(iii) Doctors have said that it is right to test all babies for PKU even though it costs the NHS money. They concluded that the benefits of testing outweigh the cost.

Use the information about PKU and your answers to parts **(i)** and **(ii)** to suggest reasons why the doctors have come to this conclusion.
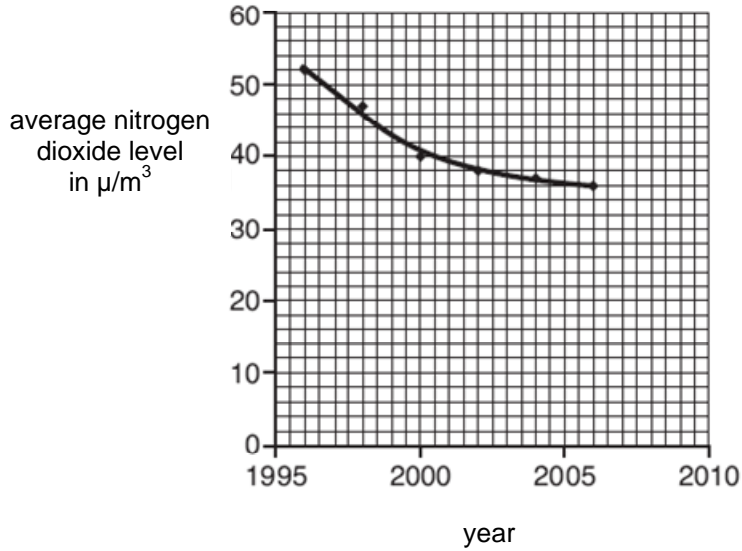
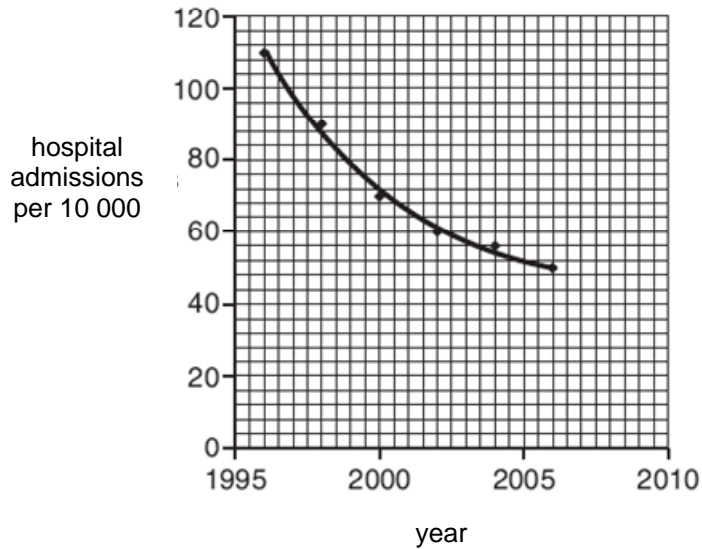...

....

.... **[3]**

[Total: 9]

3 This question is about air pollution.

(a) The graphs show nitrogen dioxide pollution in the air and the number of hospital admissions for asthma between 1996 and 2006.

average nitrogen dioxide levels in UK towns

average nitrogen dioxide level in μ/m^3

year

hospital admissions for asthma

hospital admissions per 10 000

year

(i) What was the number of hospital admissions per 10 000 people when the average nitrogen dioxide level in towns reached 40 μg / m^3?

answer = ... **[1]**

(ii) Between 1997 and 2006 the number of hospital admissions for asthma halved.

What was the change in average nitrogen dioxide levels in that time?

answer = ... μg / m^3 **[1]**

(iii) Use the graphs to explain the difference between correlation and cause.

✎ *The quality of written communication will be assessed in your answer to this question.*

....

....

....

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....

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....

.... **[6]**

(b) Between 1996 and 2006 the number of miles driven by motor vehicles in the UK increased by 50 %.

During this time, the amount of pollution by nitrogen dioxide decreased.

Here are five ways that pollution from vehicle exhausts could have been reduced.

1 manufacturing cars with more efficient engines

2 using low sulfur fuels

3 installing catalytic converters in cars

4 introducing congestion charges in cities

5 encouraging people to travel by public transport

Which of these ways would account for the **decrease** in nitrogen dioxide pollution even though the distance driven by vehicles **increased**?

Write down the numbers of the two correct answers.

.... and .... **[2]**

[Total: 10]

4 (a) Ethene is a hydrocarbon. Ethene burns to make carbon dioxide and water.

Complete the diagram to show this reaction

| ethene | | oxygen | | carbon dioxide | | water |
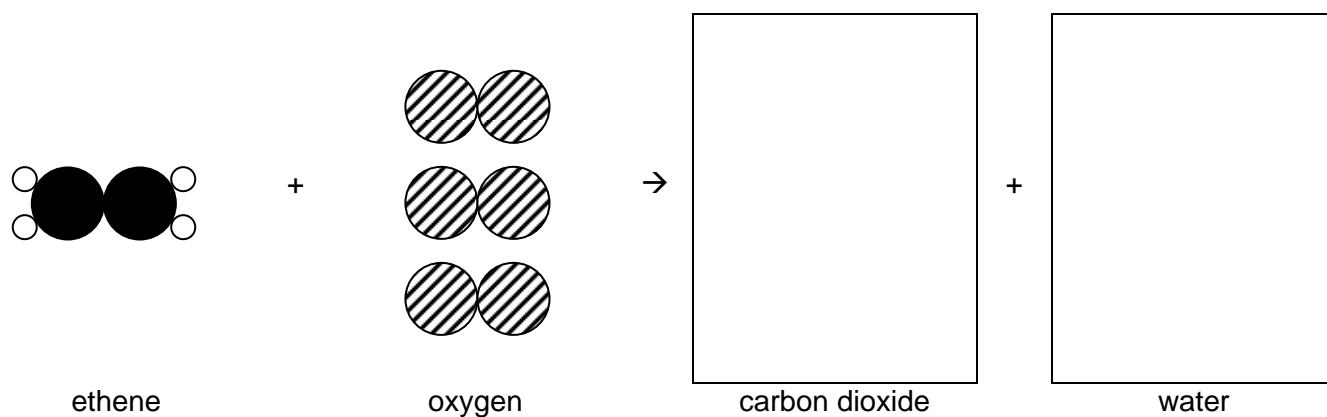
Key   ● carbon atom   ○ hydrogen atom   ▨ oxygen atom

[3]

(b) A scientist analyses the products of combustion of ethene.

He collects all the products of the reaction.

His results are shown in the table.

product	mass in g
carbon dioxide	82.0
water vapour	70.2
carbon monoxide	52.0
carbon	2.0
total	**206.2**

(i) What is the percentage by mass of carbon monoxide?

percentage by mass = ... % **[1]**

(ii) What can be concluded from these results about the conditions in which combustion occurred?

Explain your answer.

....

....

....**[2]**

[Total: 6]

5 The Earth's early atmosphere was formed by volcanic activity.

It consisted of water vapour and carbon dioxide, but no oxygen.

Explain how the amounts of carbon dioxide, water vapour and oxygen have changed from the Earth's early atmosphere to today's atmosphere.

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.... **[4]**

[Total: 4]

6 Wegener proposed his theory of continental drift in 1912.
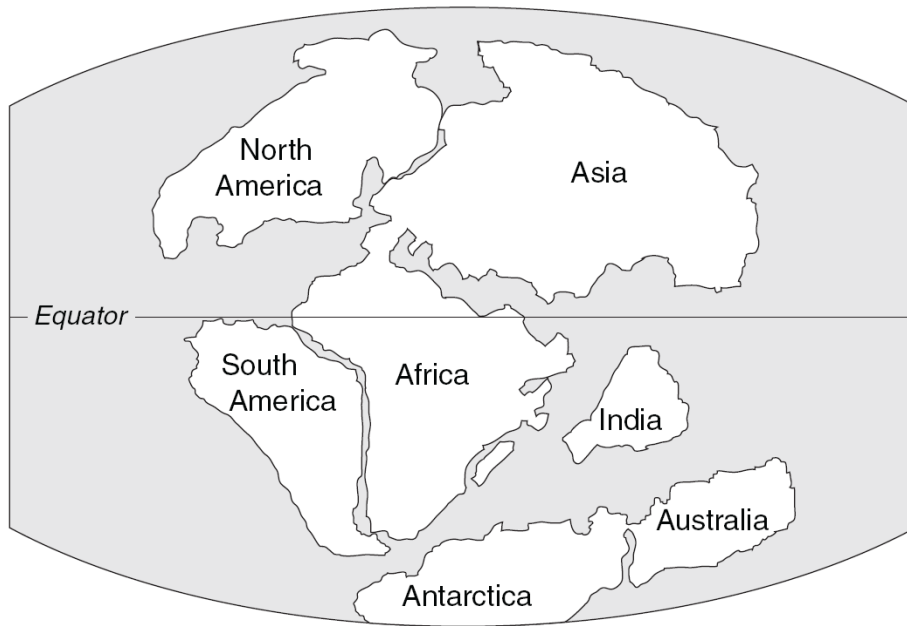
Wegener's theory was not accepted by geologists when he first suggested it.

Wegener's theory became accepted in the 1960s.

Explain why Wegener thought the continents had moved, why geologists rejected his ideas, and how the theory became accepted.

✏ *The quality of written communication will be assessed in your answer to this question.*

....

....

....

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....

....

....

.... **[6]**

[Total: 6]

7 Read the article.

'Starshade' could help us see planets around other stars

An idea for an orbiting 'starshade' could help astronomers in the search for alien life.

The giant 'starshade' would be launched into space together with a space telescope, and would orbit the Earth at a distance of around 1 million kilometres. The 'starshade' and the telescope would be around 15 000 kilometres apart from each other.

Small thruster rockets, fired by remote control from Earth, would allow scientists to move the 'starshade' in front of a star they wanted the telescope to look at. The 'starshade' would allow light reflected from planets orbiting the star to be seen.

Scientists would be able to use the reflected light to analyse the planet's atmosphere for chemicals such as oxygen, water and methane. The presence of these chemicals could be interpreted as signs of life.
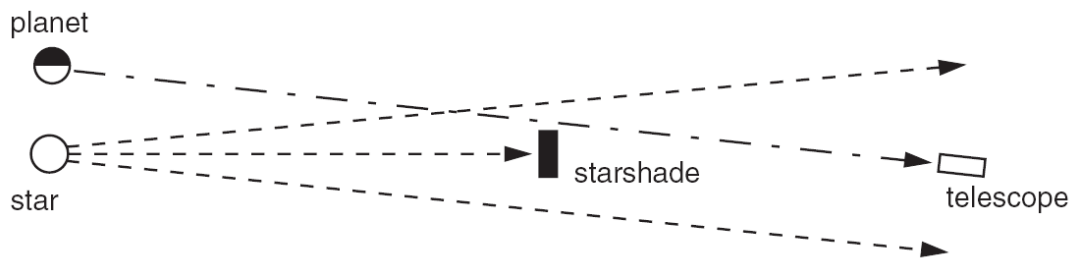
(a) Read the following statements.

Put a tick (✓) in the box next to each of the three correct statements.

The 'starshade' will block light from certain stars.	☐
The 'starshade' will be fixed to a space telescope.	☐
The 'starshade' is designed to block light from distant planets.	☐
The telescope is designed to study planets in our Solar System.	☐
The light from a planet is much dimmer than the light from its star.	☐
The light from a distant planet may show the gases in its atmosphere.	☐

[3]

(b) Most telescopes are on the Earth's surface.

This telescope and 'starshade' will be put into orbit a long way from the Earth.

Which of these statements are correct reasons for doing this?

Put a tick (✓) in the box next to each of the **two** correct statements.

There will be no light pollution. ☐

The 'starshade' will not corrode or rot. ☐

Telescopes do not need power to stay in orbit. ☐

They will be closer to the distant planets that they need to observe. ☐

The Earth's atmosphere absorbs part of the electromagnetic spectrum. ☐

[2]

[Total: 5]

8 The diagram shows a wave.
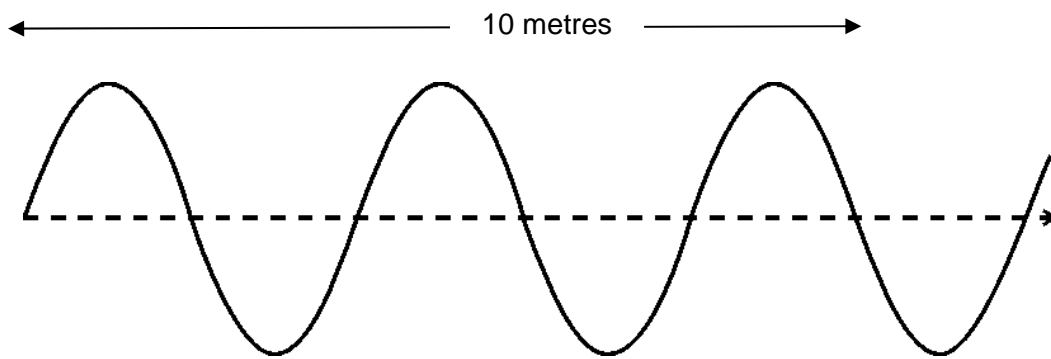
(a) Calculate the wavelength of this wave.

wavelength = ... m **[1]**

(b) Another wave has a wavelength of 5 metres.

Calculate its frequency if it has a speed of 4 m/s.

frequency = ... Hz **[2]**

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(c) The diagram shows a recording from an earthquake detector.

It has detected a P-wave and an S-wave from an earthquake.
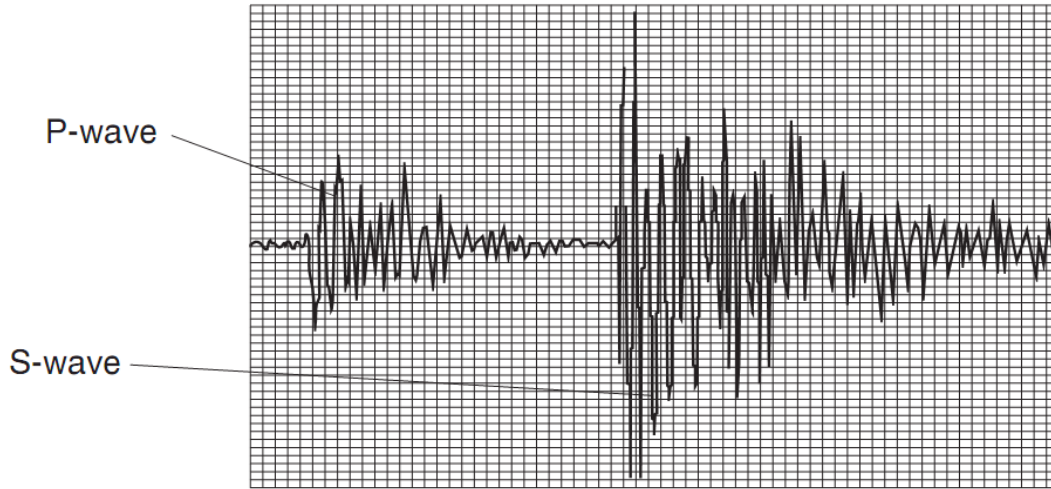
The P-wave travels at a speed of 8000 m/s, and the S-wave travels at 3000 m/s.

The two waves started at the same time from an earthquake 360 km away from the detector.

(i) Calculate the delay time between the arrival of the two waves at the detector.

delay = ... s **[2]**

(ii) Use the graph to explain why the delay between the arrival of the two waves can help save lives in the event of an earthquake.

....

....

.... **[2]**

[Total: 7]

9 Scientists think that mountains must be forming all the time.

Some of the statements below are used to explain this.

A	Mountains are part of the Earth's crust.
B	Erosion causes mountains to be worn down.
C	The Earth is older than its oldest rocks.
D	If no new mountains were formed, the continents would be flat.
E	Mountains exist today.
F	Mountains are only formed on drifting continents.

Three of the statements, when taken together, explain why mountains must be forming all of the time.

Write down the letters of these statements.

.... and .... and .... **[3]**

[Total: 3]

[Paper Total: 60]

END OF QUESTION PAPER

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GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE

SCIENCE A   **A141/02**

Unit A141: Modules B1, C1, P1 (Higher Tier)

MARK SCHEME

Duration: 1 hour

MAXIMUM MARK   60

Guidance for Examiners

Additional guidance within any mark scheme takes precedence over the following guidance.

1. Mark strictly to the mark scheme.

2. Make no deductions for wrong work after an acceptable answer unless the mark scheme says otherwise.

3. Accept any clear, unambiguous response which is correct, eg mis-spellings if phonetically correct (but check additional guidance).

4. Abbreviations, annotations and conventions used in the detailed mark scheme:

/	=	alternative and acceptable answers for the same marking point
(1)	=	separates marking points
not/reject	=	answers which are not worthy of credit
ignore	=	statements which are irrelevant - applies to neutral answers
allow/accept	=	answers that can be accepted
(words)	=	words which are not essential to gain credit
<u>words</u>	=	underlined words must be present in answer to score a mark
ecf	=	error carried forward
AW/owtte	=	alternative wording
ORA	=	or reverse argument

    Eg mark scheme shows 'work done in lifting / (change in) gravitational potential energy' (1)
        work done = 0 marks
        work done lifting = 1 mark
        change in potential energy = 0 marks
        gravitational potential energy = 1 mark

5. Annotations:
    The following annotations are available on SCORIS.

✓	=	correct response
✗	=	incorrect response
bod	=	benefit of the doubt
nbod	=	benefit of the doubt **not** given
ECF	=	error carried forward
^	=	information omitted
I	=	ignore
R	=	reject

6. If a candidate alters his/her response, examiners should accept the alteration.

7.   Crossed out answers should be considered only if no other response has been made. When
      marking crossed out responses, accept correct answers which are clear and unambiguous.

      Eg
      For a one mark question, where ticks in boxes 3 and 4 are required for the mark:

Put ticks (✓) in the two correct boxes.	Put ticks (✓) in the two correct boxes.	Put ticks (✓) in the two correct boxes.
☐	☐	⃠
☐	☐	⃠
✓	⃠	✓
⃠	⃠	✓
☐	☐	☐
This would be worth 0 marks.	This would be worth one mark.	This would be worth one mark.

8.   The list principle:
      If a list of responses greater than the number requested is given, work through the list from the
      beginning. Award one mark for each correct response, ignore any neutral response, and deduct
      one mark for any incorrect response, eg one which has an error of science. If the number of
      incorrect responses is equal to or greater than the number of correct responses, no marks are
      awarded. A neutral response is correct but irrelevant to the question.

9.   Marking method for tick boxes:

      Always check the additional guidance.

      If there is a set of boxes, some of which should be ticked and others left empty, then judge the
      entire set of boxes.
      If there is at least one tick, ignore crosses. If there are no ticks, accept clear, unambiguous
      indications, eg shading or crosses.
      Credit should be given for each box correctly ticked. If more boxes are ticked than there are correct
      answers, then deduct one mark for each additional tick. Candidates cannot score less than zero
      marks.

      Eg If a question requires candidates to identify a city in England, then in the boxes

Edinburgh	
Manchester	
Paris	
Southampton	

      **the second and fourth boxes should have ticks (or other clear indication of choice) and the
      first and third should be blank (or have indication of choice crossed out).**

Edinburgh			✓			✓	✓	✓	✓	
Manchester	✓	✗	✓	✓	✓				✓	
Paris				✓	✓		✓	✓	✓	
Southampton	✓	✗		✓		✓	✓		✓	
Score:	**2**	**2**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**NR**

10.   Three questions in this paper are marked using a Level of Response (LoR) mark scheme with embedded assessment of the Quality of Written Communication (QWC). When marking with a Level of Response mark scheme:

- Read the question in the question paper, and then the list of relevant points in the 'Additional guidance' column of the mark scheme, to familiarise yourself with the expected science. The relevant points are not to be taken as marking points, but as a summary of the relevant science from the specification.

- Read the level descriptors in the 'Expected answers' column of the mark scheme, starting with Level 3 and working down, to familiarise yourself with the expected levels of response.

- *For a general correlation between quality of science and QWC*: determine the level based upon which level descriptor best describes the answer; you may award either the higher or lower mark within the level depending on the quality of the science and/or the QWC.

- *For high-level science but very poor QWC*: the candidate will be limited to Level 2 by the bad QWC no matter how good the science is; if the QWC is so bad that it prevents communication of the science the candidate cannot score above Level 1.

- *For very poor or totally irrelevant science but perfect QWC*: credit cannot be awarded for QWC alone, no matter how perfect it is; if the science is very poor the candidate will be limited to Level 1; if there is insufficient or no relevant science the answer will be Level 0.
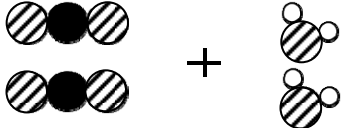
Question			Expected answers	Marks	Additional guidance
1	(a)		non-specialised / unspecialised / undifferentiated / pluripotent / totipotent specialised / differentiated	**[2]**	**accept** "cells without a job"
	(b)			**[2]**	all three boxes correct = 2 marks two boxes correct = 1 mark

Question	Expected answers	Marks	Additional guidance
1 (c)	**[Level 3]** Answer clearly explains how adult stem cells differ from embryonic stem cells **and** gives several examples of why using adult SCs may cause arguments **and** makes a valid suggestion as to why using adult stem cells may cause **fewer** arguments than using embryonic stem cells. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks) **[Level 2]** Answer omits one of the required three sections **OR** considers all three sections but lacks detail/examples. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks) **[Level 1]** Answer only considers one or two of the sections and lacks detail/examples **OR** refers to "ethical issues" without explaining what the issues are. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	**[6]**	**accept** "ASC" for adult stem cells, and "ESC" for embryonic stem cells **relevant points include:** *adult stem cells are different from embryonic stem cells because they* • are taken/made from adult tissues • (are unspecialised but) can only develop into a limited range of cell types **accept** examples of adult stem cells, e.g. from bone marrow *using adult stem cells may cause some arguments because* • it is 'playing God' / religious objection / some actions are wrong whatever the consequences • may lead to reproductive cloning • issue of obtaining informed consent from patient (e.g. brain damaged patient) • benefit(s) may not outweigh arguments against *using adult stem cells may cause fewer arguments than using embryonic stem cells because* • patient can give consent (whereas embryo cannot) • no embryos are killed/wasted **accept** "not wasting a life" **ignore** arguments based on cost
	Total	**[10]**	

Question			Expected answers	Marks	Additional guidance
2	(a)			[2]	choice of only top left box = 1 mark any line from the top left box indicates the candidates choice then look at the right hand boxes to award second mark **both** top and bottom "explanation" boxes selected = 1 mark no extra boxes allowed
	(b)		genotype is the two alleles inherited for PKU eg Pp or pp or PP phenotype is what characteristic is shown eg whether or not an individual has PKU	[2]	**accept** any letter for alleles **reject** reference to phenotype being the showing of <u>symptoms</u> (as a phenotype could equally be the presence of a non-symptomatic disease)
	(c)	(i)	59 to 71	[1]	
		(ii)	£60 000 to £72 000	[1]	**allow** 2 marks for correct answer without working shown look for error carried forward

Question			Expected answers	Marks	Additional guidance
2	(c)	(iii)	idea that benefits outweigh costs one life worth more than £60 000-£72 000 / 59-71 lives improved/owtte each year can start treatment very early to limit damage / this saves (NHS) money in the long run (because it is expensive to treat people who get ill due to PKU) / idea that parents have the right to know or can start preparing for child with PKU	**[3]**	**accept** some actions are right whatever the cost **allow** ecf from part **(i)** and **(ii)** **accept** any numbers in range
			Total	**[9]**	

Question			Expected answers	Marks	Additional guidance
3	(a)	(i)	70	[1]	**allow** any answer between 68 and 72
		(ii)	(decrease) of 13 µg/m^3	[1]	**allow** any answer between 11 and 15
		(iii)	**[Level 3]** Answer explains the difference between correlation and cause, and correctly identifies the correlation shown by the graphs. Explains clearly that nitrogen dioxide could be a cause of asthma or asthma could be caused by other factors and that more information is needed to be sure. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks) **[Level 2]** Answer does not clearly explain the difference between correlation and cause, but correctly identifies the correlation shown by the graphs. Explains that nitrogen dioxide could or could not be a cause of asthma. Understands that more information is needed to be sure. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks) **[Level 1]** Answer identifies a link shown by the graphs. Explains that nitrogen dioxide may not be a cause of asthma. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	[6]	**relevant points include:** • a correlation is present when an outcome changes as an input (factor) changes / OWTTE • graphs show a (positive) correlation between levels of nitrogen dioxide in the air and hospital admissions for asthma. • as nitrogen dioxide decreases hospital admissions for asthma decrease • a correlation does not necessarily indicate a causal link • a causal link needs a known mechanism linking the input factor and the outcome / OWTTE • nitrogen dioxide in the air is a plausible cause of asthma, but need to know how it causes asthma to be sure • asthma could be caused by other factors that need to be investigated

Question			Expected answers	Marks	Additional guidance
3	(b)		1 3	[2]	either order
			Total	**[10]**	

Question			Expected answers	Marks	Additional guidance
4	(a)			[3]	1 mark for correct drawing of CO_2 molecule 1 mark for correct drawing of water molecule 1 mark for 2 CO_2 and 2 water molecules
	(b)	(i)	25.2	[1]	
		(ii)	there was a lack of oxygen since carbon monoxide and carbon were produced due to incomplete combustion	[2]	for full marks the explanation must be linked to the conclusion
			Total	**[6]**	

Question			Expected answers	Marks	Additional guidance
5			water decreased because Earth cooled and water condensed into oceans CO_2 decreased by photosynthesis and CO_2 also decreased by dissolving in oceans/formation of fossil fuels oxygen increased through photosynthesis	[4]	
			Total	**[4]**	

Question	Expected answers	Marks	Additional guidance
6	**[Level 3]** Includes most relevant points in each category in the answer. Explains Wegener's ideas, objections to his theory, and further evidence in terms of a causal mechanism. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks) **[Level 2]** Will outline Wegener's ideas with some evidence, and make reasonable suggestions why his contemporaries did not accept it. The idea of a mechanism for continental drift likely to be absent. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks) **[Level 1]** Will outline Wegener's ideas with little supporting evidence. Objections by contemporaries likely to be personal rather than scientific. 1960s evidence likely to be missing. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	**[6]**	**relevant points include:** *Wegener's evidence* • continents 'fit together' • similar rock layers in different continents • similar fossils in different continents *his contemporaries' objections* • Wegener was an outsider/not a geologist • no continental movement detectable • existing theories (land bridges) explained fossils • no mechanism proposed for movement *for subsequent acceptance* • idea that a plausible mechanism is reasonable grounds for accepting the theory • sea-floor spreading provided a mechanism • movements in mantle as underlying cause **accept** description of magnetic stripes on seabed as evidence for seafloor spreading **ignore** references to mountain chains, unless specifically to chains on the West coast of North and South America **reject** objections to Wegener based on personality
Total		**[6]**	

Question	Expected answers	Marks	Additional guidance
7 (a)	starshade will block light … ☑ ☐ ☐ ☐ light from a planet is much … ☑ light from a distant planet … ☑	[3]	
(b)	there will be no light … ☑ ☐ ☐ ☐ the Earth's atmosphere … ☑	[2]	2 marks for correct pattern 1 mark for just one mistake 0 marks for more than one mistake (mistake = tick in incorrect box, missing tick or extra tick)
	Total	**[5]**	

Question			Expected answers	Marks	Additional guidance
8	(a)		wavelength = 10 m / 2.5 = 4 m	[1]	correct answer with no working gets 2 marks division of 10 m by an incorrectly counted number of wavelengths gets 1 mark is done consistently
	(b)		frequency = speed/wavelength = 4 m/s ÷ 5m = 0.8 Hz	[2]	correct answer with no working gets 2 marks
	(c)	(i)	time taken for P-wave to arrive = 360 000 m / 8000 m/s = 45 s time taken for S-wave to arrive = 360 000 m / 3000 m/s = 120 s, therefore the delay = 120 s – 45 s = 75 s	[2]	if distances and speeds correctly converted to compatible units but one arithmetic slip made, then allow 1 mark
		(ii)	P-wave has lower amplitude than S-wave so will cause less damage therefore the early arrival of the P-wave gives a warning that allows people time to take precautions before the more damaging S-wave arrives	[2]	for 'take precautions', accept any reasonable action that could be completed in 75 seconds, e.g. escape from building / get under table/doorway / switch off gas appliance / etc.
			Total	**[7]**	

9			B D E	[3]	any order
			Total	**[3]**	

Assessment Objectives (AO) Grid

(includes quality of written communication✏)

Question	AO1	AO2	AO3	Total
1(a)	2			2
1(b)	2			2
1(c) ✏	2	3	1	6
2(a)	1	1		2
2(b)	1	1		2
2(c)(i)		1		1
2(c)(ii)		1		1
2(c)(iii)		1	2	3
3(a)(i)		1		1
3(a)(ii)		1		1
3(a)(iii) ✏		3	3	6
3(b)	1	1		2
4(a)	2	1		3
4(b)(i)		1		1
4(b)(ii)	2			2
5	4			4
6 ✏	4	2		6
7(a)	2	1		3
7(b)	1	1		2
8(a)		1		1
8(b)		2		2
8(c)(i)		2		2
8(c)(ii)			2	2
9	2	1		3
Totals	26	26	8	60

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