
GCSE COMBINED SCIENCE: SYNERGY 8465/2H

Higher Tier Paper 2 Life and Environmental Sciences

Mark scheme

June 2023

Version: 1.0 Final



Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the examiner make their judgement
- the Assessment Objectives and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent (for example, a scientifically correct answer that could not reasonably be expected from a student's knowledge of the specification).

2. Emboldening and underlining

- 2.1** In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.
- 2.2** A bold **and** is used to indicate that both parts of the answer are required to award the mark.
- 2.3** Alternative answers acceptable for a mark are indicated by the use of **or**.
Alternative words in the mark scheme are shown by a solidus eg allow smooth / free movement.
- 2.4** Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of errors / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name **two** magnetic materials.

[2 marks]

Student	Response	Marks awarded
1	iron, steel, tin	1
2	cobalt, nickel, nail*	2

3.2 Use of symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, or uses symbols to denote quantities in a physics equation, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. At any point in a calculation students may omit steps from their working. If a subsequent step is given correctly, the relevant marks may be awarded.

Full marks are **not** awarded for a correct final answer from incorrect working.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

An error can be carried forward from one question part to the next and is shown by the abbreviation 'ecf'.

Within an individual question part, an incorrect value in one step of a calculation does not prevent all of the subsequent marks being awarded.

3.6 Phonetic spelling

Marks should be awarded if spelling is not correct but the intention is clear, **unless** there is a possible confusion with another technical term.

3.7 Brackets

(.....) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do **not** accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

3.11 Numbered answer lines

Numbered lines on the question paper are intended to support the student to give the correct number of responses. The answer should still be marked as a whole.

4. Level of response marking instructions

Extended response questions are marked on level of response mark schemes.

- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

Before you apply the mark scheme to a student's answer, read through the answer and, if necessary, annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1: Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level.

The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer. Do **not** look to penalise small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2 but be awarded a mark near the top of the level because of the level 3 content.

Step 2: Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

You should ignore any irrelevant points made. However, full marks can be awarded only if there are no incorrect statements that contradict a correct response.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question 1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.1	$= \frac{28.6}{4.4}$		1	AO2 4.1.3.2
	= 6.5		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.2	any four from: (similarities) - cell A and cell B have cytoplasm - cell A and cell B have a cell membrane (differences) - cell A has a cell wall - cell A does not have a nucleus - cell A has plasmids - cell A does not have mitochondria	for 4 marks reference to both similarities and differences is required allow bacterial cell for cell A allow liver cell for cell B ignore references to size / shape allow both cells have DNA allow both cells have ribosomes allow converse if clearly describing cell B allow cell A has DNA free in the cytoplasm allow cell A has a single strand of DNA allow description, such as (small) rings of DNA allow cell A does not have membrane-bound organelles if no other marks awarded allow for 1 mark cell A is a prokaryotic cell and cell B is a eukaryotic cell	4	AO2 4.1.3.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.3	any one from: • a group of the same / similar cells • a group of cells performing the same / similar function	ignore a group of cells unqualified ignore examples of tissue functions ignore a group of cells working together	1	AO1 4.2.1.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.4	the sugar solution was less concentrated than inside the cell		1	AO3 4.1.3.3 RPA4

Question	Answers	Mark	AO/ Spec. Ref.
01.5	Level 3: The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.	5–6	AO1 4.1.3.3 RPA4
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content method steps • use different concentrations of sugar solution • remove skin of potato • valid method of cutting potatoes • blot potato pieces to remove excess liquid (before measuring mass) • measure mass of potato pieces at start • place potato pieces in sugar solutions for a period of time • measure the mass of potato pieces after they have been in the sugar solution • calculate the change in the mass of the potato pieces • repeat experiment several times and calculate mean • calculate percentage change in mass control variables • use the same volume of different concentrations of sugar solution • cut same size / shape potato pieces such as using a cork borer • leave potato pieces in the sugar solution for a specific length of time • have solutions at the same temperature • same type / variety of potato For Level 3 the independent variable, the dependent variable and control variable(s) must be considered		

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.6	all three data points plotted correctly	allow a tolerance $\pm \frac{1}{2}$ a small square	1	AO2 4.1.3.3 RPA4
	smooth curve through all data points		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
01.7	correct reading consistent with their line	allow a tolerance $\pm \frac{1}{2}$ a small square if no line drawn allow 0.23 (mol/dm ³)	1	AO3 4.1.3.3 RPA4

Total Question 1	17
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Question 2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.1	the density of the liquid		1	AO2 4.1.1.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.2	any one from: • volume / depth of liquid • temperature of the liquid • the block used	ignore shape of block	1	AO3 4.1.1.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.3	any one from: • difficult to line up ruler and wooden block • parallax error • block may move • refraction of light • liquid surface not level	ignore human error allow there is a gap between ruler and beaker / block allow description of eye position when reading ruler	1	AO3 4.1.1.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.4	the lower the density of the liquid the greater the distance (between liquid surface and bottom of the block)	allow the greater the density of the liquid the smaller the distance (of the block below the surface)	1	AO3 4.1.1.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.5	$\rho = \frac{m}{v}$		1	AO1 4.1.1.2

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.6	$0.85 = \frac{30.6}{\text{volume}}$		1	AO2 4.1.1.2
	$\text{volume} = \frac{30.6}{0.85}$		1	
	36 (cm ³)		1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
02.7	the density decreases	if incorrect box ticked no marks can be awarded	1	AO3 4.1.1.1 4.1.1.2
	because the water particles / molecules are further apart		1	

Total Question 2	10
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Question 3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.1	(thin wall) provides a short diffusion path(way) / distance	ignore faster / easier diffusion / absorption	1	AO1
	(constant blood flow) maintains concentration gradient	allow (so) there is a short distance for substances to move allow maintains the difference in concentration	1	AO2 4.1.3.3 4.2.1.2 4.2.1.5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.2	carbohydrase	allow phonetic spellings allow amylase	1	AO1 4.2.1.5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.3	(37 °C is human) body temperature	allow (37 °C) is close to (human) body temperature	1	AO3
	(so) optimum temperature for enzymes to work	allow (so) enzymes work most efficiently allow (so) enzymes do not denature	1	AO2 4.3.1.4
		alternative route allow (so) there is sufficient (kinetic) energy (1) for enzyme and substrate collisions (1)		

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.4	starch is present because not all of it has been broken down / digested		1	AO3 4.2.1.5 RPA7
	sugar / glucose is present because (some) starch has been broken down / digested		1	
		if no other mark awarded allow 1 mark for starch and sugar / glucose are found in the tubing		

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
03.5	(iodine test is negative because) the starch is too large to pass through the tubing		1	AO3
	(the Benedict's test is positive) because sugar / glucose is small enough to pass through the tubing (into the water)		1	AO3
	by diffusion		1	AO2 4.1.3.3 4.2.1.5 RPA7

Total Question 3	10
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Question 4

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.1	incomplete combustion (of hydrocarbon fuels)	allow (hydrocarbon fuels are) burnt / combusted in a limited supply of oxygen do not accept no oxygen	1	AO1 4.4.1.6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.2	any one from: - causes respiratory problems - damages buildings - damages plants - acidifies ponds / lakes / rivers / streams	ignore acid rain allow named respiratory problem such as asthma allow causes erosion / weathering allow damages living organisms allow damage to named living organism such as trees / fish	1	AO1 4.4.1.6 4.4.2.6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.3	2800 – 600 = 2200 (million kg)		1	AO2 4.4.1.6
	(% change =) $\frac{2200}{2800} \times 100$	allow correct use of incorrectly determined value(s) for emission of pollutant ignore minus sign	1	
	= 78.57 (%)	ignore minus sign	1	
	= 79 (%)	allow a correctly calculated answer given to 2 significant figures from an incorrect attempt at the percentage change calculation ignore minus sign	1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.4	any three from: • (overall) the emission of all three pollutants decreases • the decrease in emissions of sulfur dioxide is the greatest / fastest • the decrease in emission of particulates is the least / slowest • the emissions of oxides of nitrogen increase initially then decrease	ignore references to numbers	3	AO3 4.4.1.6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.5	any one from: • less coal used in power stations • less diesel burnt / used • increased use of electric / hybrid cars • more use of renewable energy • introduction of legislation / regulation on air pollution	allow increased use of nuclear fuel in power stations allow less fossil fuels burnt / used allow increased use of named example of renewable energy allow more use of alternative energy allow use of sulfur-free petrol / diesel	1	AO3 4.4.1.6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.6	7.5 (mm) × 1000 = 7500 (µm)	allow diameter for size throughout	1	AO2
	$5000 = \frac{7500 \text{ (µm)}}{\text{real size of particle}}$	allow unit conversion at any stage of the calculation	1	AO2
	real size of particle = $\frac{7500 \text{ (µm)}}{5000}$	allow correct use of no / incorrect conversion	1	AO2
	= 1.5 (micrometres)		1	AO2
	PM _{2.5}	allow a correctly determined particulate group from an incorrectly calculated size if no other mark awarded allow 1 mark for magnification = $\frac{\text{size of image}}{\text{real size of particle}}$	1	AO3 4.4.1.6 4.1.3.1

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
04.7	trachea / bronchi secrete mucus	allow mucus is present in the trachea / bronchi / throat	1	AO1
	(mucus) traps the particulates		1	AO2
	cilia move mucus / particulates upwards / away from lungs		1	AO1
		if no other mark awarded allow 1 mark for hairs in nose / trachea trap particulates		4.3.3.3

Total Question 4	18
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Question 5

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.1	reduces competition for space / light / water / mineral ions	allow remaining trees will get more space / light / water / mineral ions	1	AO2 4.4.2.2
	(so) trees left will photosynthesise and grow quicker	allow (so) trees left will photosynthesise and grow more	1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
05.2	glucose produced in photosynthesis		1	AO2 4.2.1.1 4.4.1.2 4.2.2.5
	glucose is used / needed to make amino acids / proteins / lipids / starch / cellulose		1	
	glucose (produced in photosynthesis) used in respiration		1	
	respiration releases energy	do not accept respiration produces / makes / creates energy	1	
	(energy required) for the synthesis of new molecules from glucose		1	

Question	Answers	Mark	AO/ Spec. Ref.
05.3	Level 3: Relevant points (reasons / causes) are identified, given in detail, and logically linked to form a clear account.	5–6	AO3
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	AO2
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	AO1
	No relevant content	0	
	Indicative content environmental: - planting new trees prevents soil erosion (because) roots hold soil together - biomass is a renewable energy source (so) fewer non-renewable energy sources used - carbon dioxide removed from atmosphere by new trees / seedlings (in photosynthesis) - carbon dioxide is a greenhouse gas (so) fewer greenhouse gases in the atmosphere (so) less global warming (so) will reduce the effect of climate change biological: - new trees regenerate forests (so) maintain / regenerate habitats (so) increased decay of plant / animal material so returns minerals to the soil (so) maintain stable communities - maintain/increase biodiversity (so) maintain food chains / webs (so) maintaining/regenerating habitats (so) maintaining / introducing 'wildlife corridors' (so) providing opportunities to introduce endangered species / reduce extinction Level 3 reference to both environmental and biological benefits required	0	4.2.2.5 4.4.1.2 4.4.1.4 4.4.1.5 4.4.2.2
Total Question 5		13	

Question 6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.1		reference to synapse can be made between any two neurones		
	(sugar solution) is detected by a receptor (on antenna)	reference to impulse only needs to be given once, anywhere in the pathway, to gain maximum marks	1	AO2
	impulse passed along sensory neurone (towards CNS)	allow electrical signals / messages for impulses	1	AO1
	chemicals move across a synapse	allow impulse passed along sensory neurone (towards spinal cord / brain)	1	AO1
	(impulse) passes to relay neurone (in spinal cord / CNS) then to motor neurone	allow chemicals diffuse across a synapse	1	AO1
	(impulse) passes to effector / muscle causing muscles to contract (to extend tongue)	allow (impulse) passes to effector / muscle causing tongue to extend	1	AO1 4.2.1.6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.2	any one from: • same species of bees used • feeder the same distance (from hive) • the temperature of the environment • light levels • type of sugar • volume of solution	allow time of day	1	AO3 4.2.1.6

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
06.3	any four from: support for conclusion • bees visit the feeder more frequently on all days if there is caffeine present • the frequency of visits decreases less (over 3 days) when caffeine is present • data to support MP1 and / or MP2 limitations • only 15 bees were used for each feeding solution or sample not representative (of all bees) • there were no repeat investigations • (only mean results given) do not know how representative the mean is of data	allow only a small number of bees were used (for each feeding solution) allow only 30 bees were used allow only one type of bee used allow there may not be valid statistical differences	4	AO3 4.2.1.6

Total Question 6	10
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Question 7

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.1	the frequency of ultraviolet waves is higher than the frequency of visible light waves		1	AO1 4.1.4.3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.2	$340 \text{ nm} = 340 \times 10^{-9}(\text{m})$	allow $340 \text{ nm} = 3.4(0) \times 10^{-7}(\text{m})$	1	AO2 4.1.4.2
	$3.0 \times 10^8 = f \times 340 \times 10^{-9}$	allow a correct substitution of an incorrectly / not converted value of λ	1	
	$f = \frac{3.0 \times 10^8}{340 \times 10^{-9}}$	allow a correct rearrangement using an incorrectly / not converted value of λ	1	
	$f = 8.8 \times 10^{14}(\text{Hz})$	allow $f = 8.82... \times 10^{14}(\text{Hz})$ allow an answer consistent with their incorrectly / not converted value of λ	1	

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
07.3	the wave slows down as it passes from air into the liquid		1	AO1 4.1.4.5
	(but) one edge of the <u>wavefront</u> enters the liquid before the other		1	
	(so) one edge of the <u>wavefront</u> slows down before the other so the wave changes direction	allow bends for changes direction	1	
		if wave is used for wavefront max 2 marks if no other mark awarded allow 1 mark for wave changes speed when it crosses the boundary and changes direction		
Total Question 7			8	

Question 8

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.1	the populations of all the species that live in the rock pool		1	AO1 4.4.2.1

Question	Answers	Mark	AO/ Spec. Ref.
08.2	Level 3: Relevant points (reasons / causes) are identified, given in detail, and logically linked to form a clear account.	5–6	AO3 4.4.2.1 4.4.2.2 4.4.2.3
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content • there is no predator / starfish to eat the primary consumers so all primary consumers will increase in number • limpets and chitons will consume all the seaweed • seaweed will be unable to reproduce (quickly enough) • (so) chitons and limpets species decrease in number • from year 3 (to 8 only) barnacles and mussels are left • barnacles / mussels (only) feed on single cell algae brought in by sea water • single celled algae are replaced daily (by fresh sea water) • (so) can increase in numbers as space becomes available (on the rocks) • mussels outcompete barnacles • (because) mussels increase in number more rapidly than barnacles and so become the only species left For Level 2 links between producers and all four primary consumers needed For Level 3 an explanation of why only mussels remain is also needed		

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.3	number of species within the pool stays the same	allow number of species within the pool increases slightly	1	AO3
	(because) the community is stable with all the species in balance		1	AO2
				4.4.2.1 4.4.2.2 4.4.2.3

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.4	(after DNA replication) one set of chromosomes / DNA pulled to opposite ends of cell	allow one of each pair of chromosomes is pulled to each end of the cell	1	AO1 4.1.3.4
		ignore chromosomes are pulled to opposite ends of the cell		
	two nuclei form	allow nucleus divides ignore nucleus splits	1	
	cell divides / splits to form two cells that are genetically identical to each other	allow cytoplasm / membrane divides / splits to form two cells that are genetically identical to each other	1	
	or cell divides / splits to form two cells that are genetically identical to original cell	allow cytoplasm / membrane divides / splits to form two cells that are genetically identical to original cell allow cytokinesis		

Question	Answers	Extra information	Mark	AO/ Spec. Ref.
08.5	(in cloning) starfish does not have to find a mate	ignore reference to time	1	AO3 4.4.3.1 4.1.3.4
	(so) saves energy (in finding mate)	allow (so) starfish can reproduce when there is only one (in a rock pool)	1	
	OR in sexual reproduction there is low chance of egg and sperm meeting in water (1)	allow in sexual reproduction there is low chance of fertilisation happening in water		
	(so) less energy transferred to produce gametes (1)	allow (so) saves energy producing gametes if no other mark awarded, allow 1 mark for needs less energy		
Total Question 8			14	