

Examiners' Report June 2023

GCE Biology B 9BI0 02



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Introduction

The examiners all commented on the high quality of many of the exam scripts. Many candidates and centres had clearly prepared very well for the examination and had worked very hard. Most candidates showed good factual knowledge of most topics and wrote answers that were detailed and contained information that was of an A level standard. Some candidates underestimated the level of detail needed and tended to lack confidence using key scientific vocabulary. It is important to use all vocabulary accurately. Mathematical skills were generally very good, and most candidates seemed to have made every effort to work through all the mathematical requirements in the specification. Some candidates confused the demands of the different command words, for example, a common error was to give descriptions of data instead of giving explanations. The revised specifications have more emphasis on data handling and analysis, and it was pleasing to see that many candidates were confident when applying their knowledge to unfamiliar concepts. Some candidates still lack confidence when handling data and should be encouraged to practice as much data handling as possible prior to the examinations. The longer, six-mark questions were generally answered very well, and the examiners thought that the way that candidates now approach these questions is much improved compared with previous sessions. Overall, the examiners thought that the standard was very good, and candidates and centres should be commended for their hard work. Where candidates did less well, it was typically due to underestimating the depth needed at A level or lacking confidence when applying their knowledge to unfamiliar data series. During the exam, it is important for candidates to pace their work so that they do not get left short of time. When answering questions, they should be guided by the mark allocation rather than trying to ensure that they fill every line.

Question 1 (b)

This question presented candidates with a scenario about the effect of high temperature on the structure of egg white albumin protein. Many strong answers were seen that gained at least two marks, but fewer went on to gain all three. Most candidates recognised that proteins denature with higher temperature, and many went on to explain that this denaturation is due to the breakage of bonds such as hydrogen and ionic bonds. A significant number of candidates incorrectly suggested that covalent bonds such as disulfide and peptide bonds would also break. Fewer candidates explained that hydrophilic, charged amino acids would be on the outside of the proteins due to interactions with water and that after heating, the hydrophobic amino acids would be exposed so that they tend to associate together. The question stem stated that there were both polar and non-polar amino acids present – candidates should always be aware that information in a question is usually given for a reason. (b) Raw egg white is a liquid containing dissolved ovalbumin, a globular protein.

Ovalbumin has some amino acids with polar R-groups and some amino acids with non-polar R-groups.

If raw egg white is heated to a temperature above 70 °C, it irreversibly changes into a solid.

The diagram shows how the structure of ovalbumin changes when heated.



Explain why heating ovalbumin to temperatures above 70 °C causes egg white to change from a liquid into a solid.

(3)use if you heat a prote structure of the protein getting denatured. The egg wi because 15 pro Tein 01 15

This answer gained one mark for the idea that protein denatured. No further detail was given.



When referring to denaturation, always state which bonds are broken.

(b) Raw egg white is a liquid containing dissolved ovalbumin, a globular protein.

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Explain why heating ovalbumin to temperatures above 70 °C causes egg white to change from a liquid into a solid.

when the oval burnin is heated above 70°C, the globular protein (soluble structure because it's hydrophilic on the between the outside, and has a circular structure) loses it's bonds present in the molecule (broken down by high temperatures) (Hydrogen bands, disulphide, ionic bonds), so it looses it's tertiary structure and the so it's R-groups are no longer polar, so it cannot form hydrogen bonds with water to dissolve in it, therefore it becomes insoluble, and becomes a solid, & non circular shucture.



This answer gained three marks. The candidates states that hydrogen bonds are broken leading to the loss of tertiary structure and also states that the hydrophilic amino acids are dissolved in water on the outside. There are a few confused aspects in the answer but the three points are not negated.

(3)



Ovalbumin has some amino acids with polar R-groups and some amino acids with non-polar R-groups.

If raw egg white is heated to a temperature above 70 °C, it irreversibly changes into a solid.

The diagram shows how the structure of ovalbumin changes when heated.

heat to temperature above 70°C ovalbumin in ovalbumin in raw egg white solid egg white Explain why heating ovalbumin to temperatures above 70 °C causes egg white to change from a liquid into a solid. (3)when the substance ovalburnin is exposed to high temperatures its structure charges. Proteins are enzymes so this can be considered an example of an enzyme denaturing because it is at a point beyond its optimum temperature. The tertiary structure is diminished and the coils of proteins unwind amino acids unwind. This is an irreversible charge once an egg white is cooked, it turns solid 50 and cannot be restored to its initial liquid form.



Question 2 (b)

This maths question required candidates to calculate the volume of protein digested. Candidates needed to calculate the volume of the cylinder before and after incubation. The volume digested was calculated by subtracting the initial volume by the final volume. The answer also required units to be converted from cm into mm and the answer given to two significant figures. Many strong answers completed the calculation to gain all three marks. Common errors where candidates did not gain full credit were:

- only calculating the volume of the cylinder at the end.
- not giving the answer to two significant figures.
- incorrectly converting units from cm into mm.

(b) A student investigated the digestion of gelatine protein by pineapple juice.

This is the method used.

Step 1: Make a solid disc of gelatine protein, with a depth of 1 cm, in a Petri dish.

Step 2: Cut out a circular well with a diameter of 2 cm in the centre of the disc.

20mm

- **Step 3:** Fill the well with pineapple juice.
- Step 4: Incubate the dish for one hour at 37 °C.
- **Step 5:** Measure the diameter of the area that has been digested by the bromelain enzyme.

The diagram shows a gelatine disc before and after incubation with the pineapple juice.



The diameter of the circular area that had been digested after one hour was 6 cm. Calculate the volume of gelatine that had been digested.

Give your answer, in mm³, to two significant figures.

Volume of a cylinder = $\pi r^2 l$

```
\pi = 3.14
```

```
Usince of digitial area : 3.14 \times 30^2 \times 10 = 28260 \text{ mm}^3<sup>(3)</sup>
Usince of well: 3.14 \times 10^2 \times 10 = 3140 \text{ mm}^3
28260 - 3140 = 25120 \text{ mm}^3
```

Answer 25120 mm³



This answer gained two marks. The volumes, unit conversion and subtraction have been calculated correctly but the answer was not given to two significant figures. (b) A student investigated the digestion of gelatine protein by pineapple Juice.

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Give your answer, in mm³, to two significant figures.

Volume of a cylinder =
$$\pi r^2 l$$

 $\pi = 3.14$
 $\pi (1)^2 x l = 3.14$
 $\pi (10)^2 x l = 3.14$
 $\pi (10)^2 x l = 3.140$
 $\pi (10)^2 x l = 3140^{(3)}$
 $\pi (10)^2 x l = 2826 v$
 $\pi (30)^2 x l = 2826 v$
 $28260 - 3140 = 25120$
Answer $\frac{25120}{2500}$ mm³



This correct answer gained all three marks. All the working is very clear – this is an example of good practice as even if the final answer is incorrect, some credit may be gained from the working.



Always show working for calculations – you may get some credit even if the final answer is incorrect.

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This is the method used.

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Give your answer, in mm³, to two significant figures.

Volume of a cylinder = $\pi r^2 l$

 $\pi = 3.14$

Before incubation: Mxr²xL 1000 m Mx 10- x 10-1000 m

97K-11K-84 (3) 9000H - 1000T = 8000 m

Answer 25000. mm³

After incubation HK12XL HX30X10=9100011



This is another good example of a correct answer that gained all three marks. The working is very clear.

Question 2 (c)(i)

This question assessed the candidates knowledge of the effect of increasing substrate concentration on enzyme activity. Strong answers described the increase in rate, followed by the levelling off and went on to explain that increasing the substrate concentration increases the rate due to more enzyme-substrate complex formation and the rate levels off when the enzyme concentration becomes limiting. Weaker answers tended to just give descriptions and some candidates did not read the question carefully and compared the rates at different concentrations of copper sulfate.

The student also investigated the effects of changing the concentration of a soluble protein, and the addition of copper sulfate on the rate of digestion of this soluble protein by bromelain.

The results are shown in the graph.

rate of digestion



(i) Explain the effect of increasing substrate concentration on the rate of between digestion of the soluble protein. - ensume + submate

aigest	tion o	is ma	he are	more	rbstrat	e mole	clues u	mian	can tor	mare
210 mon	ne - si e prot	Nostat	e LOMA Mydroty	sed and	M M pro peph	en yme de borol	6 roken	nain (an increa	are is sed chan
-> but	odth 1	rale	of dige	stoon e	ventral	y plai	eus e	even u	ith in	creasing
800800	ate	wn cer	vraus	h beeg	wse th	e cenu	urrati	ish + nu	mper	r
enny	mes	bec	iones	a li	witing	Fa CTON	' <i>a as</i>	all th	e activ	estes



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rate of digestion

concentration of soluble protein

(i) Explain the effect of increasing substrate concentration on the rate of digestion of the soluble protein.

(2)easer wh concentration ma longer rises



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The results are shown in the graph.

rate of digestion

concentration of soluble protein

(i) Explain the effect of increasing substrate concentration on the rate of digestion of the soluble protein.

(2)

```
Increasing substrate concentration increases the rate of
```

reaction and so the rate of digestion, but this then levels

```
off as the substrate has been used up.
```



The student also investigated the effects of changing the concentration of a soluble protein, and the addition of copper sulfate on the rate of digestion of this soluble protein by bromelain.

The results are shown in the graph.



concentration of soluble protein

(i) Explain the effect of increasing substrate concentration on the rate of digestion of the soluble protein.

The the rate of digestion increases the concentration of soluble protein also increases and then levels off. This is because as it increases enzyme-subsmate complexes are being formed, and when it levels off, there ezyper no available enzymes or substrates. Increasing substrate are monon rate of digestion increases as substrates are more concentration means the likely to come into contact with enzymes.



(2)

Question 2 (c)(ii)

This question presented candidates with the effects of adding different concentrations of copper sulfate on the rate of digestion of protein by the enzyme. Most candidates recognised that the copper sulfate was acting as an inhibitor although a significant number incorrectly stated that it was a competitive inhibitor or stated that it was either competitive or non-competitive. The rate never reaches the maximum rate even when there is a high concentration of substrate so that the inhibitor would not be competitive. Strong answers explained that the copper sulfate would cause a change in the shape of the enzyme so that the substrate would no longer fit into the enzyme's active site. Some candidates gave very impressive answers correctly referring to allosteric binding and how it changes the active site shape. Weaker answers tended to give vague descriptions of the results.

(ii) Explain the effect of copper sulfate on the rate of digestion of the soluble protein.

		1
As the concentration	n of copper suffate	increases, the
rate of digestion	devreased, this is	shown by a
less steep line of	the graph. Furt	hermore as concentrata
of copper sulfate	increased the grap.	h fieldened set
faster this can s	ngget that copper	sulfate acts
as an inhibitor	so that substrates	do not bind to the
enzyme.	(Total fo	or Question 2 = 8 marks)

(2)



This very good answer gained two marks. The candidate states that the copper sulfate is an inhibitor and prevents the substrate from binding with the enzyme.

(ii) Explain the effect of copper sulfate on the rate of digestion of the soluble protein.

(2)1 rato & digeton Increasing the oncentration of copper sulfite at totand at high or concentrations of Cusa, the rate became over dover because CuSO, acts as a non-competitive inhibitor and bindy to the allotonic site which changes the shape of the active site and prevents the estimate from binding to the enjume so the rate of digestion reached a laser maximum at higher concentration



This excellent answer gained both marks. The candidate clearly states that the copper sulfate is a non-competitive inhibitor and binds to allosteric sites.

(ii) Explain the effect of copper sulfate on the rate of digestion of the soluble protein.

Copper	suffate	acts	all a n	on-competitive	inhibitor	umiting
the vote	guin art	which	digestion	of copper ange	brometain	occurs



This answer gained one mark for correctly stating that copper sulfate is a non-competitive inhibitor.

(2)

Question 3 (a)(ii)

This question required candidates to calculate the width of a cell when given the diameter of the image and the magnification. The question also required a unit conversion and the final answer to be given to one decimal place. Most candidates were able to gain at least one mark with many gaining both. The main error was incorrectly converting between cm and micrometres. Candidates should be fully familiar with how to convert between units.

- (ii) In the photograph, cell X has a width of 0.8 cm.
- \$000 \$mm)×1000
- The magnification of the photograph is ×1500.

Calculate the actual width, in micrometres (μ m), of cell X.

Give your answer to one decimal place.



(ii) In the photograph, cell X has a width of 0.8 cm.

The magnification of the photograph is ×1500.

Calculate the actual width, in micrometres (μ m), of cell X.

Give your answer to one decimal place.

$$M = \frac{1}{A} \qquad A = \frac{1}{M} \qquad x 1000$$

= $\frac{0.8}{1500} = 0.00533$
0.0 0533mm = 0.53pm 0.5
Answer MAB μ m

This answer gained one mark for a correct magnification calculation but the final answer is wrong due to an incorrect unit conversion.

(ii) In the photograph, cell X has a width of 0.8 cm.

The magnification of the photograph is ×1500.

Calculate the actual width, in micrometres (µm), of cell X.

Give your answer to one decimal place.

$$A = \frac{I}{m} = \frac{0.8}{1500} = 5.33 \times 10^{-4} \text{ cm}$$
(2)
= 5.33 × 10⁻⁶ m $1 \text{ m} = 1 \times 10^{6} \mu \text{ m}$
.: = 5.33 µm

Answerμm

(2)



Question 3 (b)(i)

This question was well answered and most candidates were able to interpret the histogram to determine the correct number.

Question 3 (b)(ii)

This question discriminated well generating a wide range of scores. Candidates were presented with unfamiliar data regarding the percentage of DNA damage in sperm and the risks of pregnancies not going to term. Candidates were then asked to evaluate whether the data and investigation supported a conclusion. With evaluation questions, full marks cannot be awarded if only one side of the argument is given. Strong answers often stated that there was a higher percentage of sperm with more than 25% DNA damage associated with pregnancies not going to full term and that when there was little DNA damage, there was a high chance of pregnancies going to full term. Stronger answers also went on to consider the investigation and often referred to other factors that may affect the pregnancies, such as maternal health and the unevenness of the group sizes. Weaker answers tended to get one or two marks, often for a description of how the data supported the conclusion and / or one reason why the investigation may not be fully valid.

(b) Some pregnancies do not develop to full term, so no baby is born.

Damage to the DNA of sperm is thought to be one cause of pregnancies not developing to full term.

Scientists investigated if there is an association between the production of sperm with damaged DNA and the risk of pregnancies not developing to full term.

The percentage of sperm cells with DNA damage was determined for 130 men where there was a history of pregnancies not developing to full term.

The percentage of sperm cells with DNA damage was measured for 78 men where pregnancies developed to full term.

The graphs show the results of this investigation.



Percentage (%) of sperm cells with DNA damage

(ii) The scientists concluded that having more than 25% of sperm with damaged DNA leads to a high risk of pregnancies not developing to full term.

(4)

Analyse the data to evaluate this conclusion.

The condusion is not valid because deta is not reliable
as the sample size is too small. The data shows worrelation
but not calls a fim. The pregnancies not developing to full
term might be due to other factors. Nowever, it
added be said the conclusion is valid because the
first sruph shows the highest number of men (22) had between
4D and 45%. Homage of sperm DNA damage while graph 2
had the nighest number of men 121) with between
O and 51. of spirm with DNA damage, amuch conver
percentage siggesting TONA demage of spern Leads to more
men with a him priter whose pregnancies don't develop
2 Fill type, This is also seen by the distilution of the bars in
the this graphs. In the first one most men house more than 271.
damaged sperm but in the second are mait then have left
them 251 Not valid conclusion because many less men in group where
prograncies develop to full term. traph + No man with more man 80%. Imma sed sput n (Total for Question 3 = 8 marks)



This is an excellent answer that gained all four marks. The candidate has considered the reliability of the data (sample size), the possibility of other factors and how the data supports the conclusion from both graphs.



With evaluate questions, make sure that you have points that both support and counter an argument or conclusion.

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Analyse the data to evaluate this conclusion.

(4) supporti the condución CIVI show e Mal number edipern that didu't have perttple thers MCV gryph damagod spermi Mre second aucly any nen had hull naged guan nty lit ma 6 TO men 0-51. mth dama



This answer gained two marks. The candidate has correctly stated that there is an increase in the number of men with more than 25% of sperm with DNA damage associated with pregnancies not going full term and that when pregnancies do go full term, there is a high number of men with 0-5% damage. (b) Some pregnancies do not develop to full term, so no baby is born.

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Percentage (%) of sperm cells with DNA damage

(ii) The scientists concluded that having more than 25% of sperm with damaged DNA leads to a high risk of pregnancies not developing to full term.

(4)

- The number of men that have a history
of full kern freque pregnancies with percenter
@ of 25% or lower of the sperm
coll 5 with ONA damage 13 much
higher from 12
- This shows that handing a lover 25%.
DNA danage cites a much higher chance
07 Successful pagnacies.
- M me graph they is see the dard
Abso Shows the 118 our up 130 men have
have have man 25%. sperm damage.
- that is over 90%. If the men having
a high risk of pregnances not developing full per
- Thes conclusion is availad as the dary
prove S SK

Analyse the data to evaluate this conclusion.



This answer gained one mark for stating that there are more sperm with greater than DNA damage associated with pregnancies not going to full term. No consideration of the quality of the investigation is given. (b) Some pregnancies do not develop to full term, so no baby is born.

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Scientists investigated if there is an association between the production of spermwith damaged DNA and the risk of pregnancies not developing to full term.

The percentage of sperm cells with DNA damage was determined for <u>130 men</u> where there was a history of pregnancies not developing to full term.

The percentage of sperm cells with DNA damage was measured for 78 men where pregnancies developed to full term.

The graphs show the results of this investigation.



Percentage (%) of sperm cells with DNA damage

(ii) The scientists concluded that having more than <u>25% of sperm with damaged</u> DNA leads to a high risk of pregnancies not developing to full term.

Analyse the data to evaluate this conclusion.

(4)- most men where pregnances of portners developed to Full term (60 men) had 25% or less DNA damaged sperm cells, suggesting that less mon 257 danage doesn't have a high risk of net developing to all term pregnancies - most men (118) with danieged not dene coping gue term had more mon 25% damaged DNA so more than 25% does lead to a higher risk of not developing to full telm. - However, results are not reliable as 130 men were tested with pregnancies net developing to full term and only 78 for developing to full be term, which is a smaller sample sile - We don't know other factors that may cause results - age ernale's genetics that could cause indeveloped pregnancie,



This is an excellent answer that gained all four marks. The data is used to explain how it supports the conclusion and the candidate then goes on to explain that the samples are uneven, there are other factors and that maternal health needs consideration.

Question 4 (a)(ii)

This question presented candidates with diagrams and information about the structure of samphire and asked them to explain how samphire is adapted to live in areas next to the sea where it is often flooded with sea water. Strong answers explained:

- the small leaf surfaces and thick cuticle that prevent transpiration and evaporation of water.
- the presence of air spaces to store carbon dioxide for photosynthesis.
- the use of the stem as an organ of photosynthesis since the leaf surface area is small.
- the presence of salt in the cells to lower the water potential and prevent water loss by osmosis.

Weaker answers tended to pick up one or two marks, often for the reduced water loss due to the small leaf surface area and thick epidermal layer. Some candidates simply gave descriptions of the adaptations rather than explanations – it is important to be fully familiar with all the command words. Weaker answers often referred to the salt concentrations but did not refer to water potentials or the prevention of water loss by osmosis. At A level, it is important to refer to water potentials rather than concentrations. (ii) Samphire is one of the few plants that can grow in the areas close to the sea. Samphire plants have very small leaves and swollen stems.

The diagrams show a samphire plant and a cross section through the stem of a samphire plant.



Explain how samphire is adapted to grow in areas of saltmarshes closest to the sea.

(4)

Swollen stem to be able to resur the wegger wind me remain upright. Lase sugarce area for increased rate of -gus exchange for photospheril, as more light ga canton distile absorbed. This way curice to prevet water row vie mentranspiration so the water on se yes por photospheris. Context with in- spaces to inverse as exchange and high salt concreting to lower water potentia thege water in more in via amoris. Chloropless in pelisade cell to assort Schright for photometice there more growth.



This is a very good answer that gained all four marks. The candidate explains that the waxy cuticle reduces water loss and that the high salt concentration lowers the water potential, reducing water loss by osmosis. The candidate also correctly points out that the palisade cells in the stem contain chloroplasts and so are photosynthetic.



Make sure that you know what all the different command words require. For example, explain and describe require different types of answer. (ii) Samphire is one of the few plants that can grow in the areas close to the sea. Samphire plants have very small leaves and swollen stems.

The diagrams show a samphire plant and a cross section through the stem of a samphire plant.



Explain how samphire is adapted to grow in areas of saltmarshes closest to the sea.

(4) · samphine is adapted by it has a min epidemis a waxy citicle which reduces the water loss from the pland, which helps due to be high rate of transpround ut the coast. " the contex with high salt concentration = for for bagger low water potential = water mores to center by osmotis · pathade als cortaining chipoplast = to purposition I able to occur the where way awoul the plant = leaves which marknises mins duenst here new due to sulique asserting vate of the plant being submerged a insurreger by see = Hilait.



This answer gained four marks. The candidate has correctly stated that the samphire has a thick epidermis to reduce transpiration, there is a lower water potential in the cells reducing water loss by osmosis and that the palisade cells in the stem perform photosynthesis.
(ii) Samphire is one of the few plants that can grow in the areas close to the sea. Samphire plants have very small leaves and swollen stems.

The diagrams show a samphire plant and a cross section through the stem of a samphire plant.



Explain how samphire is adapted to grow in areas of saltmarshes closest to the sea.

(4)Speed Causes vouspiration (boute LOSS au gover hear th Sen amph where one adaptation leaves veSn which LOSS rough also have a n Ning thick ep dern. n Stop ha protection ado ben and ult Contey nosture ih nuth



This answer gained two marks for correctly explaining that the reduced leaf surface area reduces transpiration and that the thick epidermis will also reduce water loss from the surface. (ii) Samphire is one of the few plants that can grow in the areas close to the sea. Samphire plants have very small leaves and swollen stems.

The diagrams show a samphire plant and a cross section through the stem of a samphire plant.



Explain how samphire is adapted to grow in areas of saltmarshes closest to the sea.

(4)As the coast is windy and this increases the rale of transpiration and evoparation, sampline have wary cutiles. This reduces water loss. The carles tous of has cens with a law water potential, meaning that when sait water woshes are the plans, any fresh water will make in Uia asmosis and not saltions. They grow have be so their teaner paliside cells with chlargelastica can out photosynthesis.



Question 4 (b)(i)

This question presented candidates with data about biodiversity of species near the coast and asked them to give two limitations with using ACFOR data. Strong answers referred to ACFOR data not being qualitative, being subjective and not being able to be used for statistical testing. Most candidates were able to gain at least one mark with many going on to gain both. (b) A group of students investigated succession in a saltmarsh.

The students measured several factors at 5 m intervals along a transect, starting at the edge of the sea.

The factors measured were:

- ACFOR scales for samphire, sea lavender, and scurvy grass
- index of diversity of all plant species
- · percentage of silt (mud) made up of organic material.

The results are shown in the table.

Factor		Distance from sea/m					
		0	5	10	15	20	
ACFOR scales	Samphire	Abundant	Common	Rare	Absent	Absent	
	Sea lavender	Absent	Rare	Common	Common	Rare	
	Scurvy grass	Absent	Absent	Rare	Occasional	Abundant	
Index of diversity for all plant species		0.20	0.54	0.85	2.54	2.85	
Percentage of silt made up of organic material (%)		15	10	25	35	55	

 Give two limitations of using ACFOR scales to compare the distribution of different plant species.

(2)The scale is subjective so the same mules of genies could be could differely alt



(b) A group of students investigated succession in a saltmarsh.

The students measured several factors at 5 m intervals along a transect, starting at the edge of the sea.

The factors measured were:

- · ACFOR scales for samphire, sea lavender, and scurvy grass
- · index of diversity of all plant species
- percentage of silt (mud) made up of organic material.

The results are shown in the table.

Factor		Distance from sea / m						
		0	5	10	15	20		
	Samphire	Abundant	Common	Rare	Absent	Absent ~		
ACFOR scales	Sea lavender	Absent	Rare	Common	Common	Rare		
	Scurvy grass	Absent	Absent	Rare	Occasional	Abundant		
Index of diversity for all plant species		0.20	0.54	0.85	2.54	2.85		
Percentage of silt made up of organic material (%)		, 15	10	25	35	55		

(i) Give **two** limitations of using ACFOR scales to compare the distribution of different plant species.

(2)

compend

ulitative, not quantitative (abundance is subjective) 0 alegories of abundance chuined



(b) A group of students investigated succession in a saltmarsh.

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The factors measured were:

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The results are shown in the table.

Factor		Distance from sea/m					
		0	5	10	15	20	
	Samphire	Abundant	Common	Rare	Absent	Absent	
ACFOR scales	Sea lavender	Absent	Rare	Common	Common	Rare	
	Scurvy grass	Absent	Absent	Rare	Occasional	Abundant	
Index of all plant	diversity for species	0.20	0.54	0.85	2.54	2.85	
Percentage of silt made up of organic material (%)		15	10	25	35	55	

 Give two limitations of using ACFOR scales to compare the distribution of different plant species.

(2)be Mar Soneone 512



This answer gained two marks for the idea that the data is subjective and that it is not numerical.

Question 4 (b)(ii)

This question presented candidates with information about how the organic material in the soil and abundance of different plant species changed with distance from the sea. The question explained to candidates that as distance increases, the age of the land increased suggesting that the coast area was an example of succession. Many candidates recognised that succession had occurred, and that samphire was an example of a pioneer species that helps to stabilise the substrate. Strong answers also explained that the plant species numbers changed with distance from the coast as each species has its own niche and the plants compete with each other. Many candidates also correctly explained that abiotic factors such as salinity and exposure change with distance from the sea and the plant species all have their own adaptations. Weaker answers tended to simply describe the data in the table without giving any explanations for the changes, for example, many candidates pointed out that the mass of organic material increases with distance from the sea but did not link this to decay or release of mineral ions.

(ii) Saltmarshes are produced by deposits of silt (mud) from rivers.

As the distance from the sea increases, the age of the saltmarsh increases.

Explain the changes in distribution of the species as distance from the sea increases.

(4)The samphire is the pioneer species, able to survive On from the sea , where sea lavender and . The samplire then decomposes a t surve into the soll forming a hur releases ents the land habitable for sea lavender, as seen sea where the kand is sea laverder 5m from oble timed, with sarry grass This proce s then con colonise the to 10m sea. These from th march the % of organic material in the cha Hover nerase y for a greater diversity time ted eventually anythere outcompl sea laven rare by 20m sea abundant grass has



This is an excellent answer that gained four marks. The candidate explains that samphire is a pioneer species, succession has occurred and explains the release of nutrients due to decomposition. The candidate also explains how the different species must compete with each other at different areas of the land. (ii) Saltmarshes are produced by deposits of silt (mud) from rivers.

As the distance from the sea increases, the age of the saltmarsh increases.

Explain the changes in distribution of the species as distance from the sea increases.

(4) Samphire is abundant closest to the sea as it is the adapted to the conditions there It needs. most well 1000 to organic material (15%) percentage o prequency up the dec shore, its reases annenity in we ages as competition. Survi sactors such biohc penentage organic requires material 0) abundant gnow : it absent at 15% TO IS order Invender belomes Lommon at Jea more from sea. This 40 120 organic in the silt M matter penentage the decomposition samphire OIN

This answer gained two marks for the explanation about how samphire is adapted to live close to the water and how decomposition produces the organic material in the soil.

(ii) Saltmarshes are produced by deposits of silt (mud) from rivers.

As the distance from the sea increases, the age of the saltmarsh increases.

(4)

Explain the changes in distribution of the species as distance from the sea increases.

Across the solutionarian there are different stages of succession that
has ound at 0 in to the sea the is low diversity of
plant specifes becase there is uss sill of acomic marenial so the
soil is use view with arganic matter that decays to add while to the
Seil, meretue uss plant species are supported by a thinner hums
ranger Samphon is aloundant closer to the sea becare it has specific
adaptaitas that allow it to surve in that habilit. As disiance
from the sea increases the index of diversity increases because the
that decays to build up the human layer becase there is also mare
Silt ment adds substeads to the Scil. therefore mar spills of plans
can be specied suncer results in mae micrus so even mae
different species colorise the and futur away from the sea.



This excellent answer gained all four marks. The candidate explains that succession has occurred and only samphire has the adaptations to live by the sea. The candidate also explains that decomposition releases nutrients into the soil and that there are different niches at different distances.

Question 5 (a)(ii)

This question tested the candidates understanding of the sensitivity of different areas of the retina. Most candidates recognised that the central area contains more cones than rods and many went on to explain that rods are more sensitive due to the summation of input onto bipolar neurones. Some candidates confused rods and cones and incorrectly stated that there are more rods in the central area of the retina.

 (ii) Explain why the centre of the retina is less sensitive to low intensity light than the outer areas.

- rod cells are less sens
- rod cells are high sensitive to vight
- whereas cone ceus are less sensitive
to light and take in bright light
- cone ceus located in centre of refina
- rode cells located in other areas



This answer gained two marks for correctly stating that the central area of the retina has more cones and that cones are less sensitive to light.

(2)

(ii) Explain why the centre of the retina is less sensitive to low intensity light than the outer areas.

(2) The force, or cete, has one cells rathe " and celly which legs sensitive to light the red cells as they have no unmarting , each cell leads to me going his cell mille bey added aguits rod cally base I line lift intersities



This answer gained both marks for correctly stating that the fovea has more cone cells and that the cone cells are less sensitive.

(ii) Explain why the centre of the retina is less sensitive to low intensity light than the outer areas.

(2)The centre known contains u (0) senseture Low le Cell 607 Ser istre a



This answer gained two marks for correctly stating that the fovea contains more cone cells which are less sensitive. The candidate also correctly explains that the rod cells have synaptic convergence. (ii) Explain why the centre of the retina is less sensitive to low intensity light than the outer areas.

3 he pover, which any This contenty cells, cone d cue 4 Sipdan e ell synapsed to Only One ling densis light lac 92 require higher vollage 5 b 5 20 adir Adentical general for rody Ve opt biopder cell. rhacopsih less with Algoneal, no while outer -35 3 Mac due b Summa and rods, which presence of rhoeoger, sub-threshold lle polenticals add to will え up Co light. densy law

Results Plus Examiner Comments

This answer gained two marks for correctly stating that the centre of the retina has more cones and that cones contain less sensitive iodopsin rather than rhodopsin. (2)

Question 5 (b)(ii)

This question tested the candidates understanding of X-linked conditions by presenting them with a pedigree diagram of a family with red-green colour blindness. Candidates were asked to select one aspect of the diagram to explain how it showed that the condition is caused by a recessive allele. Most candidates were able to correctly gain one mark for identifying a cross where parents did not have the condition, but offspring did. Many then went on to explain that the genotype of the mother must be X ^H X ^h if the son had the condition. Some candidates incorrectly stated that both parents would be heterozygous (as the father has only one X chromosome) and others did not give a specific example of a cross that showed that the condition is recessive.

(2)Perfor 6 and perfor & are both not rolour blind, and 6 = × R× because they have 11 who is colour blind, is it was dominant the children would be colourblind. 6 must be a camer hence phenotype of colomblind not present in her.



This very good answer gained two marks. The candidate has stated that parents 6 and 7 are not colour blind yet 11 is. They then go on to explain that the genotype of the mother must be heterozygous.

⁽ii) Explain how this pedigree diagram demonstrates that red-green colour blindness is caused by a recessive allele.

(ii) Explain how this pedigree diagram demonstrates that red-green colour blindness is caused by a recessive allele.

The Person 6 and person 7 do not have me
condition but their child, person 11, does have
the condition go may must have been
hererozygious for me recessive allele.
person 4 has to be a conter for the condition and
her doughter had he condition best and her
husbad had it too.



This answer gained two marks for selecting the cross with parent 4 and then going on to state that parent 4 must be heterozygous since her daughter has the condition and the father also has the condition.

(ii) Explain how this pedigree diagram demonstrates that red-green colour blindness is caused by a recessive allele.

(2)

(2)

pavenus 6 and 7 must be neterozygotes that carry
the recessive gene which is passed on to 11
Males only have one & chromosome and so they are mare

Whele to have recessive alle



(ii) Explain how this pedigree diagram demonstrates that red-green colour blindness is caused by a recessive allele.

Cross between 3 and 4 produces idness hle with an cóles. plindness. hetero zygours So 4 must be

(2)



(ii) Explain how this pedigree diagram demonstrates that red-green colour blindness is caused by a recessive allele.

(2)Family number 8 (Penale with colour blindness) could anly inherited colour blindness is both addedes where recossive. The mather was a carrier and the father was calour beind repulsion in the child to have colourblindness. However number p's siletings did not have the ressessive all der unless number 10 is heterozypaus and a camer.



This answer gained two marks for identifying a correct cross and giving the correct genotype of the mother.

Question 5 (c)(i)

This challenging question was well answered by many candidates. Most were able to gain at least one mark, typically for deducing that the allele was recessive. Many outstanding answers were seen that explained that the allele must be recessive and autosomal (or not sex-linked) and then gave evidence from the cross to support their answer. The examiners were impressed with how well many candidates understood the pedigree diagram. It was clear that many candidates annotated the script to show the genotypes of each individual – this is good practice (although not essential) as it helps candidates work out how the alleles are passed through the generations.

(c) Pingelap is an (solated island in the Pacific Ocean.

On Pingelap, between 4% and 10% of the population has a condition called achromatopsia. This means that they are unable to see any colour.

In most other countries, the incidence of achromatopsia is around 0.003%.

(i) The pedigree diagram shows the people who are and are not affected with achromatopsia in a family.



Deduce how achromatopsia is inherited.

Use the information in the pedigree diagram to support your answer.

(3)recessive Callie 5 Ind R have essiv 1/ROUS 2 tro m



This excellent answer gained three marks. The candidate has stated that the allele is autosomal and recessive and identified two crosses to explain their deduction. (c) Pingelap is an isolated island in the Pacific Ocean.

On Pingelap, between 4% and 10% of the population has a condition called achromatopsia. This means that they are unable to see any colour.

In most other countries, the incidence of achromatopsia is around 0.003%.

(i) The pedigree diagram shows the people who are and are not affected with achromatopsia in a family.





Deduce how achromatopsia is inherited.

Use the information in the pedigree diagram to support your answer.





This excellent answer gained three marks for stating that the condition is not sex-linked, is recessive and gives the correct evidence from the diagram to support their answer. (c) Pingelap is an isolated island in the Pacific Ocean.

On Pingelap, between 4% and 10% of the population has a condition called achromatopsia. This means that they are unable to see any colour.

In most other countries, the incidence of achromatopsia is around 0.003%.

(i) The pedigree diagram shows the people who are and are not affected with achromatopsia in a family.



Deduce how achromatopsia is inherited.

Use the information in the pedigree diagram to support your answer.

(3) 11 alto Smal is not sex linked it was 3 son of and a who achtomatopsia. recessive condition due to the 20 achio matopil a carria have a hromatons have this `wr be cause nas au hmma are erozy gow ne - 50 tosomal autroma



This is an example of another excellent answer that gained three marks for correctly deducing that the allele is recessive and not sex-linked and explains how the diagram shows this.

Question 5 (c)(ii)

This question required candidates to use their knowledge of population genetics to explain why colour blindness is more common on the island of Pingelap. Many candidates were correctly able to recognise that a genetic bottleneck / founder effect had occurred that reduced the gene pool and made it more likely that carriers of the allele would have children together. A few candidates gave vague answers about genetic variation being reduced but most were able to gain at least one mark with many going on to get both.

(ii) In 1755, a tsunami reduced the population to 20 people and there has been little immigration to the island.

In 2022, the human population of Pingelap was approximately 250.

Explain why the incidence of achromatopsia is higher in Pingelap than in other countries.

Due to reduced population it means genetic variation is less. Due to this individuals in Pingelop Will have less people to pick to mate with. Due to this the recessive allele is passed on more as it is present more compared to countries with greater population as there genetic variation & higher.

(2)

This answer gained one mark for the idea of reduced variation but there is no explanation as to why there is reduced variation.

(ii) In <u>1755</u>, a <u>tsunami</u> reduced the population to 20 people and there has been little immigration to the island.

In 2022, the human population of Pingelap was approximately 250.

Explain why the incidence of achromatopsia is higher in Pingelap than in other countries.

(2) ettec niticasty a icine red achromato psia OY 50 in popula increases Jas grea ienal tion, and he



This answer gained both marks for correctly referring to a bottleneck and the effects of this on the diversity of alleles. (ii) In 1755, a tsunami reduced the population to 20 people and there has been little immigration to the island.

In 2022, the human population of Pingelap was approximately 250.

Explain why the incidence of achromatopsia is higher in Pingelap than in other countries.

(2)

The tounami caused a generic bottlenech due to the population size being suddenly

reduced. This means a smaller population remaining has a reduced gene pool with

less variety of alleles and reduced generic diversity. As a result, in breeding depression

occurs, because it is more likely that an individual inherits two pecellike alleles,

because the allele prequency has increased. It is Therefore more likely for Oftoponsis

be homogygous recessive, camping two recessive achromatopoia alleles.

This answer gained two marks for correctly stating that a genetic bottleneck had occurred and linking this to a reduced gene pool.

Question 6 (a)(ii)

This question asked candidates to explain how the membrane of a neurone depolarises. Most candidates were able to gain at least one mark with many going on to gain two. Most candidates recognised that the sodium ion channels close whilst potassium ion channels open. A few candidates incorrectly stated that the potassium ions would enter the neurone. Candidates should always be careful to refer to the movement of ions rather than simply referring to the movement of potassium or sodium.

(ii) Explain how membrane proteins cause the change in potential between Y and Z. (2)Nad Causinc more neu 50 3 04 ICA



This answer gained two marks for correctly stating that the sodium channels will close and the potassium channels will open. The candidate also states that the potassium ions will diffuse out.



Always refer to sodium or potassium ions when describing their movement.

(ii) Explain how membrane proteins cause the change in potential between Y and Z.

(2)

• they close all the channels in the membrane membrane so no ions can enter, but Not and Ut are both still actively being pumped out causing hyperpolarisation in the neurone



(ii) Explain how membrane proteins cause the change in potential between Y and Z.

(2)

The sodium channel close, and putassium channel open

More positive ion moves out, less positive ion move in,

decreasing potential difference.



Question 6 (b)(ii)

Many candidates found this question challenging. The question required candidates to analyse the effect of ouabain, an inhibitor of the sodium-potassium exchange pump, on the activity of a motor neurone. The candidates were shown the effect of the ouabain on the resting potential across the neurone membrane. Strong answers explained that the resting potential was unable to be maintained as there is no pumping of sodium ions out or potassium ions in, so that there would not be a gradient of sodium ions across the membrane, thus preventing depolarisation when stimulated. Weaker answers tended to suggest that the ouabain prevented stimulation of the membrane from reaching a threshold potential or suggested that the ouabain acted on sodium or potassium channels directly. Some candidates gave vague answers restating the question stem by simply stating that the sodium-potassium exchange pump no longer works. (ii) Ouabain inhibits sodium-potassium exchange pumps.

The diagram shows the effect of ouabain on the potential difference across a motor neurone membrane.



(3)

Explain how ouabain prevents the transmission of nerve impulses.

renting potential of the neurone remains at The - Formy until the ouabain was added. · Sudden increase in the potential difference because the Nat/kt punp is stopped. This prevents the exchange of Nat and K+ from the autice to the inside. doemit experiment generate a This general potential and hence the transmission of nenere impuse decreases. This as a result burles the reunstrammitter and prevents the brain from protecting it and sending signals to (Total for Question 6 = 7 marks) the motor newsone - no repronse from the estectors e.s. musiles / grandes



This answer gained no marks. The candidate has referred to the sodium-potassium exchange pump stopping but not given a direction for the movement of the ions. There is no reference to preventing depolarisation in the correct context.

(ii) Ouabain inhibits sodium-potassium exchange pumps.

The diagram shows the effect of ouabain on the potential difference across a motor neurone membrane.



Explain how ouabain prevents the transmission of nerve impulses.

(3) habain Wut/ht pumps that blows Vesting 6 Cannot newa porchim since Constant NUNY unner Cm't ht and Dumped wall philas In Mule and m DONTR INSIN Nar Cm a anno, Opu o 017 14 ove in Clenil no



This answer gained all three marks. The candidate clearly states that the pump can no longer pump sodium ions out and potassium ions in. The candidate goes on to state that this means that the potential difference across the membrane rises and so it is unable to depolarise. (ii) Ouabain inhibits sodium-potassium exchange pumps.

The diagram shows the effect of ouabain on the potential difference across a motor neurone membrane.



Explain how ouabain prevents the transmission of nerve impulses.

(3)

6tr soduum- potassuin LUL & Outrain mubited restan Q Cumes the Potentia net ùs. Main Faine and ut 00 ian art not puniped No out and um an not AUMAN attive transport 64 Cans rear instead asteriam the the bum non regettive 60 has 4 same potentia Gatil LAS ED BOD repolarisation can't be transmitted 01 infulses can't- occur.

This is a very good answer that explains that the sodium ions are no longer pumped out and potassium ions not pumped in, meaning that the resting potential is not maintained. The candidate goes on to correctly state that the membrane reaches an equilibrium.

Question 7 (a)(ii)

This question asked candidates to explain why DNA sequences of genes are more variable than the sequences of amino acids in proteins. Most were able to correctly state the code is degenerate so that there are many different codons that can produce the same amino acid. Fewer candidates went on to gain a second mark for recognising that there are non-coding regions or introns within genes or that changing amino acid sequences may affect protein function (which may lead to organisms not surviving).

(ii) Explain why the DNA sequences of genes are more variable than the sequences of amino acids in the proteins coded for by these genes.

Several different DNA codons can code for the same acids as the ONA" is degenerate. There are s also DNA variability of the aninoacid sequences. the

(2)



This answer gained two marks for correctly describing that the code is degenerate and that non-coding regions also exist.

(ii) Explain why the DNA sequences of genes are more variable than the sequences of amino acids in the proteins coded for by these genes.

(2) Be cause dea enerate B so many diff erent A opena Code trib for 5 11 Sama anino acro also regions non - co sin the are ih a see 50 100 20 Vane trone are



This excellent answer also gained two marks for describing the code as degenerate and stating that mutations may occur within introns.

Question 7 (a)(iii)

This question tested the candidates knowledge of the use of DNA technology in classification, a subject covered in Topic 3 of the specification. Most candidates were able to correctly gain at least one mark, typically for referring to gel electrophoresis or DNA sequencing. A significant number of candidates went on to gain a second mark for explaining how the sequences could be analysed using bioinformatics or comparison of banding patterns from gel electrophoresis.

(iii) Describe how the scientists could use technology to find out whether gene we sequences of two species are similar.

(2)

DNA cut into fragment placed Gel electrophotesis
ONA bina to aye allow flourest another taye in pass
with current off. arrient without on -ve DNA move the
compare bands of DNA from species to see how
similar. Also through bioformatics alle to
put data DNA into technology iden hily how similar.



This answer gained two marks for the use of gel electrophoresis and the comparison of banding patterns. The candidate has also correctly stated that bioinformatics can be used. (iii) Describe how the scientists could use technology to find out whether gene sequences of two species are similar.

(2)

Use get erectrophonesis and observe if

- bonding patterns are similar like the position or bonds
- & width of bonds are the same-than it is similar.
- Also use RNA sequencing + bioin formatics.



This strong answer gained two marks for correctly stating that gel electrophoresis can be used, the banding patterns compared and that bioinformatics can be used.

(iii) Describe how the scientists could use technology to find out whether gene sequences of two species are similar.

(2) A sequencing can Ne DNA duplins J, then ~ refector ich Tes 2 patterus are w most smiler



This answer gained two marks for correctly describing the use of DNA sequencing and comparing fragment sizes using gel electrophoresis.
Question 7 (b)

This longer answer, level-based question assessed candidates ability to analyse data relating to the use of seed banks as a method of conservation. The data showed the differences in genetic diversity of different groups of plants in seed banks compared with in the wild. Data also showed how much the genetic diversity of seeds changes depending on the length of time spent in the seed banks. Strong answers gave detailed descriptions of how the genetic diversity differed or increased over time, went on to suggest explanations such as the effects of mutations when growing in the wild, genetic drift, and natural selection, and discussed the validity of the data by explaining overlapping error bars and the number of outliers present in the graph. Weaker answers tended to gain one or two marks for giving pure descriptions of the data. When discussing data in these longer questions, candidates should give descriptions, identify patterns, suggest explanations, and comment on the validity of the data.

*(b) The scientists measured the mean genetic diversity of species in the wild and the mean genetic diversity of the same species in seed banks.

The species examined included:

- trees
- non-woody species of plant
- plant species classed as endangered
- plant species classed as not endangered
- plants of economic importance that are harvested by people.

The scientists also measured the mean number of differences in the DNA sequences of the seeds that had been stored for different lengths of time compared with plants in the wild.

The graphs show the results.



Error bars represent +/-1 standard deviation n = number of different species



Analyse the data to discuss the results of this investigation.

(6)

hist graph, it is clear that there is more genetic From the than seed banks diversity in the wild for trees, non-woody species and non-endangered species. However, there is more generic diversity in endangered species in seed banks than the wild, and sligning more for species g economic importance too. For the latter categories, the sample size was smaller. This suggest that ex situ conservation is providing good conservation g endangered species due to the increased generic diversity. These results are significant with no error bar over ap for all but species g economic impmance which only have I all difference between generic diversion in situ and ex situ. from the second graph, it is evident that as age seeds in seed banks increase, the generic maturial of the seeds vary more q from the unud plant. This suggests Freexample, seeds only just added to the bank had no dijuence in DNA sequences whereas some had 82 by 30 years. However, others remained with low levels of diffurences, so seed banks can stribe a varia tool. In addition, seeds in the wild

experience differences in ONA sequences due to generic
Vanation, which is not taken into account here.
Therefore, while seed ONA may change, this caud be
repeable of the wild population, and it is very endent
from the first graph that seea banks new preserve generic
diversity y endangered species which cauld otherwise be lost
completely.



This is a good answer that gained four marks. The candidate has described several patterns in the data and has discussed the validity of the data. There are few attempts at an explanation so the answer is classed as Level 2. *(b) The scientists measured the mean genetic diversity of species in the wild and the mean genetic diversity of the same species in seed <u>banks</u>.

The species examined included:

- trees
- non-woody species of plant
- plant species classed as endangered
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Error bars represent +/-1 standard deviation n = number of different species



Analyse the data to discuss the results of this investigation.

(6)

for most species in figure 2, genetic amosty in all species apoint mon
and species of economic incontance
endangened (petter, ") significantly higher in the wild thin in seed banks. This
is due to the different conditions; in the wild, there is more competition, hershe
conditions ine exchance and rin of aircale. This forces peches to adapt
to condition the sunside and natural telection takes place, where species with
advantageous allely sunne and reproduce offspring. The reason for generic diversity
being high in seld bonne for endanged speared is because seed banks have
a higher amount of seeds to reproduce compared to menical where mespecies
is facing possible activition - the nights the population, the greate the the
genetic anesity one to greater gove pool. In figure 2, as me one of second in
seed barre invenes, me mean number of differences in DNA sequences from secon
bonns compred in mild present. This is because of regain, aiffeent consommetal
conscitution that eithe inhibit or encourage natural election gutallo mine
untations occur in the nild turn in controlled envolument, like Level barned. Oreall,
general diversity is higher in wild plants/seed, compared to specific monsteld bounds.



This is a good, strong answer that gained four marks. The candidate describes several patterns in the data and gives explanations for differences in genetic diversity. There are no real attempts to discuss validity so the answer is Level 2.

*(b) The scientists measured the mean genetic diversity of species in the wild and the mean genetic diversity of the same species in seed banks.

The species examined included:

- trees
- non-woody species of plant
- plant species classed as endangered
- plant species classed as not endangered
- plants of economic importance that are harvested by people.

The scientists also measured the mean number of differences in the DNA sequences of the seeds that had been stored for different lengths of time compared with plants in the wild.



Error bars represent +/-1 standard deviation n = number of different species



Age of seeds in seed bank/years

Analyse the data to discuss the results of this investigation.

(6) but positive correlation The graph 2 shows 0 d Sprea the C er 101 S OCY rona a es 5 O 9 CIES C Speci nave 0 NONO Cross .CI 5 0 00 1.



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- trees
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- plant species classed as endangered
- plant species classed as not endangered
- plants of economic importance that are harvested by people.

The scientists also measured the mean number of differences in the DNA sequences of the seeds that had been stored for different lengths of time compared with plants in the wild.

The graphs show the results.





The data indicates that overall the genetic diversity of plants in the wild is greater planes in seed banks - this may be due to fewer seeds in seed banks -: th are ferrer allete is a reducedgene pool. However, for an endangered species this staten does not apply as for the wildendangered species genetic diversil =0:2 au, however for the seed banks In banks of this species the genetic dirersity =0.0. . This may be as an endangened species will have ferrer individuals and may have at a specific alleles which have been advantageous . surrival was due to direction at selection medifference between the genetic Largest diversity is in non woody plants which have a difference of 4.2-1-2= 3 a.v. which There are no overlaps in the species

ting that the data is significant e data for the species OF esid Importance, this Indicat RONOMIC and no significar diff RUM dat e is a positive con rer 50 ences in DN The bank Oł experience or m POIDS 10 octive - enviror emperature ator 6.0 69 5 P ores Chin IONQ CAY ODDI ome. -ar uestion 7 = 11 marks) Total foi



This is a strong answer that gained six marks. The candidate has given descriptions of patterns in the data, offered explanations, and commented on the validity and significance of the data. This makes the answer Level 3.

*(b) The scientists measured the mean genetic diversity of species in the wild and the mean genetic diversity of the same species in seed banks.

The species examined included:

- trees
- non-woody species of plant
- plant species classed as endangered
- plant species classed as not endangered
- plants of economic importance that are harvested by people.

The scientists also measured the mean number of differences in the DNA sequences of the seeds that had been stored for different lengths of time compared with plants in the wild.

The graphs show the results.



Error bars represent +/-1 standard deviation n = number of different species



Mean number of differences in DNA sequences from seed bank compared with wild plant

Age of seeds in seed bank/years

Analyse the data to discuss the results of this investigation.

(6). Comple show, that species in the wild mostly had more geehr divenity. Biggest difference (3a.m) seen tehrem and seed banked non-moochy species. Give Suis non-overlapping . And Die to the feel that lots of woody speciel exist in the wild are able to reproduce proclusion KXUally varied garates by nerosis (variation by multi crossover assorthen) and increasing genetic i-dependent veriation reed lanks, reeds on havested ger pool. In 100 number of plants and with limited gentre ranzace vior (ofter goin in contolled, sterike conditions cannot freed freely). Species of economic i-portance had little difference (error overlap is might not be skhohrally significant to be cloned I grownay a renoculture hard species may with little crossificeding and low genche diversity

- Endangered species in the mild had less genetic diversity as low number of individuals, small gere pool, population Lottleneck leads to lots of i-breeding and genetic drift alleles last and gentic diversity low. In good Janks, plants havested may have pupperley to inkibred to maximize diversity using shed Looks and artficial pollination & have higher diversity. . Other graph dues that difference i- DNA else incorres with age of seeds. (Total for Question 7 = 11 marks) . They is because seeds in seed sanks are not germinated (kept is airhight, cold, low noishare conditions) - herew wild plants are growing and evolving by natural selection as they adapt to new selection pressure, Pandam notations may immer in population of they could provide selection advantage to relection preserve so ilented, causing change in population DNA . However, repults may not be entirely reliable as different sample sizes for experient one and relatively weak correllation in experiment too (experient two may also not so consul relationship) continuation of procedural error any have occurred



This is another excellent answer that gained six marks. Descriptions of data patterns are given, explanations are offered and there are comments about validity at the end of the answer.

Question 8 (a)

This question asked candidates to explain the role of a double circulation in the maintenance of a high metabolic rate. Most candidates were able to gain at least one mark with many gaining both. Common correct answers included the double circulation allowing different pressures to be maintained in the systemic and pulmonary circulatory systems and separating the oxygenated and deoxygenated blood. Some candidates did not mention that the rapid supply of oxygen enables a high respiration rate but only referred to metabolic rate that was in the question stem.

8 (a) Explain why a double circulatory system enables mammals to have a high metabolic rate.

seperates oxygenated and deoxygenated blood allowing it to go to where it need to be to deliver the De or concet some

This answer gained one mark for correctly stating that oxygenated and deoxygenated blood are kept separate. There is no reference to oxygen supply for respiration.

(2)

8 (a) Explain why a double circulatory system enables mammals to have a high metabolic rate.

(2)

(2)

The The asuble and and deakysenated blood where allows the property and the advertes in the advertes in the body and lawer in the lungs. This means more blood can be asygenated at the lungs and more asygenated states of an be delivered anound the body. Cather Respiring ceres therefore have better a system repairs they. Can perturn more aerobic respiration to produce more fits as an energy source for predebulic reactions. Keeping asygenated and deakysenated blood. Reparate also means there are steeper concentration goodiant is more gas exchange can accul at the energy and more at the respirits josines.



This answer gained both marks for correctly stating that oxygenated and deoxygenated blood is kept separate and that this enables a rapid supply of oxygen for respiration.

8 (a) Explain why a double circulatory system enables mammals to have a high metabolic rate.

- Decayyer	iated o	nd axig	enated	blood	doesn't	Mik	making	,4	
more ef	ficrent	meaning	more	plood	Сен	be t	onspo-lea	<u>et</u>	higher
press are	therefor	e more	orggen	is de	livered	0-104A0	1. the	body	
therefore	more	respiration	0- COA	ocur	mean	'ng M	etabolic	nake	
increases	AS	there	5 100	ore f	TP.	-98.09			



Question 8 (b)(i)

This mathematical question required candidates to calculate a heart rate. Many excellent answers were seen that gained both marks for correctly determining the time taken for one beat and then dividing 60 by this time. Some candidates gained one mark for a correct method after calculating the wrong time for one heartbeat. A few candidates misread the scale on the graph but often gained a mark for a correct method.

(b) Abnormal heart rhythms can be identified in ECG traces.

The diagram shows ECG traces of a person with a regular, healthy heart rhythm and a person with an abnormal heart rhythm.



Person with abnormal heart rhythm

(i) Calculate the heart rate, in beats per minute, of the person with an abnormal heart rate.

Give your answer to the nearest whole number.

$$\frac{60}{0.84} = 71.43 \text{ BPM}$$



(2)



(b) Abnormal heart rhythms can be identified in ECG traces.

The diagram shows ECG traces of a person with a regular, healthy heart rhythm and a person with an abnormal heart rhythm.





(i) Calculate the heart rate, in beats per minute, of the person with an abnormal heart rate.

Give your answer to the nearest whole number.

60 =72.7272 0.825

Answer 4

beats per minute

(2)



Question 8 (b)(ii)

This challenging question required candidates to analyse the ECG trace for a patient and explain how the trace showed that there was damage to the septum. Some excellent answers were seen that clearly stated that there was a longer gap between the P and QRS complex, although some candidates showed confusion with labelling the letters on the trace. A significant number of candidates recognised that there was a delay between atrial and ventricular systole and also went on to state that there may be damage to the bundle of His or Purkinje fibres in the septum.

(ii) Explain how the ECG traces show this abnormal heart rhythm is due to damage to the septum in the centre of the heart between the left and right sides.

(2)

There is a longer delay between the Pwave and QRS complex, so there is

a longer delay between atrial depolarization and rentricular depolarization. This means conduction from the atrioventricular nocle is delayed a cross the

ventricles is delayed, so the ware of depolarisation is not travely being transmitted

down the bundle of His and, which is located in the septim between the left

and night side. This means rennicular symple is delayed because the war of

depetarisation takes longer & pass from the AV anovenmentaria mode, down he

Dundle of His and pulunie spres.



This excellent answer gained both marks and illustrated all three mark points. The candidate describes the delay between the P and QRS complex and goes on to state that there is a delay between atrial and ventricular systole, possibly due to damage to the bundle of His.

(ii) Explain how the ECG traces show this abnormal heart rhythm is due to damage to the septum in the centre of the heart between the left and right sides.

(2) The ECG of the person with the The ab p-ECEG abnormal my thin that the p have happens 1DO heart MOW) the atria occurs depolarisation of hickly. The ipmplex QRS there is 9 the apre repolansation of The vontric les. Domage The 10 deconsigenated and Oxy genated Septum mean that WOU to travel down impulses would not be able w Arouta bundle of HIS the Through. ptum, runovah pu venthillar systole caus hence the delar QRS wmplex



This strong answer gained two marks for correctly stating that there is a long delay between the P and QRS complex and that this may be due to damage to the bundle of His.

Question 8 (b)(iii)

This question presented candidates with information about the structure of atropine and asked them to explain how its action can lead to an increase in heart rate. Many excellent answers were seen that explained that the atropine would bind to acetylcholine receptors and prevent acetylcholine that had been released from parasympathetic neurones from binding. Most candidates were able to gain at least one mark with many going on to gain all three.

(iii) Bradycardia is a heart condition that results in a heart rate that is <u>slower</u> than <u>normal</u>.

Atropine is a drug that can be used to treat some forms of bradycardia.

Atropine is a competitive inhibitor of acetylcholine.

Explain why atropine will lead to an increase in heart rate.

(3)(Ach) Acetylcholine is a neurotransmitter used in the arasympathetic nervous system lower the Atropone has some choline hece to prevent a setylcholine membrane



(iii) Bradycardia is a heart condition that results in a heart rate that is slower than normal.

Atropine is a drug that can be used to treat some forms of bradycardia.

Atropine is a competitive inhibitor of acetylcholine.

Explain why atropine will lead to an increase in heart rate.

(3)

Acetycholine is a bransmitter that is sent down the parasympathetic nerve to decrease the heart rate. If atropine is a competitive antibuter, this means that acetylcholine can no longer mind to receptors to decrease the nearly rate, further leading to an increase in heart rate because nothing slowing heart rate dum and acetylcholine can no langur bend

This very good answer gained three marks. The candidate correctly states that acetylcholine is released by the parasympathetic nervous system and slows the heart rate. The candidate also goes on to state that atropine will prevent acetylcholine binding to receptors.

Question 8 (b)(iv)

This question assessed the candidates understanding of how exercise leads to the stimulation of the medulla so that heart rate is increased. Many excellent answers were seen that gave excellent detail. Stronger answers referred to the release of carbon dioxide from respiration, the decrease in pH of the blood, and the detection of this by chemoreceptors in the aorta and carotid artery. A few candidates wrote answers that lacked detail, for example, they would refer to chemoreceptors but not give a location, or they would refer to respiration but not mention the release of carbon dioxide. Some candidates confused baroreceptors with chemoreceptors and some candidates explained how the sympathetic nervous system causes an increase in heart rate due to noradrenaline release.

(4)

(iv) Describe how exercise leads to the stimulation of the cardiac centre in the medulla oblongata.

As we exercise more CO2 will entend be produced in the body. As a result this decreases PH of blood and Chemoreceptors detect this change. As a result of this signals must be sent to the brain to increase heart rate which we know is controlled by the Medulla Oblongata. anthinearrow By doing this the medulla oblongata Will increase heart rate So more oxygen enters the body and CO2 is removed from the body.



This answer gained two marks. The candidate stated that the pH of the blood would decrease leading to the stimulation of chemoreceptors. Carbon dioxide is mentioned but not linked to respiration.

(iv) Describe how exercise leads to the stimulation of the cardiac centre in the medulla oblongata.

Exercise a increase is ph due to a increase is
cor cereb, mis is reconized by chemoreceptor union
rea a impuble to the medulia to increase inpulses
down the parasympathetic perve to jourge depolationing
te jan



This answer gained two marks for the role of chemoreceptors and the sending of impulses to the medulla. Carbon dioxide is not linked to respiration and the pH fall is not linked to the blood.

(4)

 (iv) Describe how exercise leads to the stimulation of the cardiac centre in the medulla oblongata.

(4) In our bodie, when exercising the cor concentration in our vised increases union reach to a rower pH. this is by the chemoreceptors in the caronid anener, detected abrea and budy which then sends impulses to the Ourdio centre in the medulla oblongata to be praced by the brain. due to respiration and lacture building.

This answer gained four marks. The candidate states that the blood pH falls and that this is detected by the chemoreceptors in the carotid artery which send impulses to the medulla.

Question 9 (a)

This question presented candidates with pyramids of biomass for a marine food chain in two sequential months, and the pyramid of energy for the whole year. Most candidates were able to gain one mark with many going on to gain two or three. Many candidates correctly described the changes in phytoplankton and zooplankton between November and December but some only described the changes in one trophic level or described the pyramid for one month. Many candidates were able to describe the decreasing energy along the food chain and give a reason for the decrease in energy such as excretion or indigestible material. Some of the strongest answers explained that the pyramid of energy was taken for the whole year and the pyramids of biomass are 'snapshots' of one month.

Phytoplankton are producer organisms in marine ecosystems.
Zooplankton are small animals that live in the surface waters of the oceans.
The diagram shows a food chain for the South Atlantic Ocean.





This answer gained one mark for the correct idea of a decrease in energy along the food chain. The description of the changes in phytoplankton and zooplankton is confused. 9 Phytoplankton are producer organisms in marine ecosystems.

Zooplankton are small animals that live in the surface waters of the oceans.

The diagram shows a food chain for the South Atlantic Ocean.



(a) Comment on the shapes of these three ecological pyramids.

(3)id of biomass for november and Puran year are umler. Cor one recieved similar energy to everagy 50 Kg. Pyrania biomass the rca per rent ecemper diffe the 200 plank ton nonem with nu himas helember en huring may tin ON) to runpon



This answer gained one mark for a correct description of the changes of phytoplankton and zooplankton biomasses between November and December. Phytoplankton are producer organisms in marine ecosystems.
Zooplankton are small animals that live in the surface waters of the oceans.
The diagram shows a food chain for the South Atlantic Ocean.





This strong answer gained three marks. The candidate describes the changes in biomass correctly and explains that the zooplankton will have consumed the phytoplankton. The candidate also goes on to explain why the pyramid of energy decreases.
Question 9 (b)(i)

This question required candidates to calculate the efficiency of energy transfer between two trophic levels. Most candidates were able to complete the calculation correctly although a few did not give their answer to the nearest whole number as instructed.



(b) The diagram shows the flow of energy through this food chain.

All values are measured in kJ m⁻³ yr⁻¹

 (i) Calculate the percentage efficiency of energy transfer between the phytoplankton and the zooplankton.

Give your answer to the nearest whole number.

$$\frac{6800000 - 60800000}{6800000} \times 100 = 10.58$$

$$\frac{11\%}{11\%}$$
Answer **482**



This correct answer gained both marks. The candidate has also shown their working clearly.

(b) The diagram shows the flow of energy through this food chain.



All values are measured in kJ m⁻³ yr⁻¹

(i) Calculate the percentage efficiency of energy transfer between the phytoplankton and the zooplankton.

Give your answer to the nearest whole number. $6.8 \times 10^6 - 6.08 \times 10^6 = 720000$ (2)

Answer 10,59 %



Question 9 (b)(ii)

This challenging question asked candidates to explain why the transfer of energy along a food chain is less efficient when an endotherm is in the chain compared with an ectotherm. The question assessed the candidates knowledge of thermoregulation and energy transfer through food chains. Some excellent answers were seen that explained that endotherms regulate their body temperature, lose more heat, and so have a higher metabolic rate. A significant number of candidates were confused by the terms ectotherm and endotherm and incorrectly suggested that ectotherms will continuously lose more heat energy and so have higher metabolic rates. Candidates should be fully conversant with all technical terms used in the specification.

(ii) Common seals and orcas are endotherms.

Sardines are ectotherms.

Explain why the transfer of energy from sardines to orcas is less efficient than the transfer of energy from zooplankton to common seals.

	(3)
sudies are externes. Sadires use about none	<u>~~</u> 57
during netabolic processes they zooplankton theree, no.	e elegy
is wastel during excretile. No - energy is lost through	sh reas
mare energy is lost as noverent of there are a	one Adiseshly
vots of suches such as bacs of vig has R is	60
efficient.	



This answer did not gain any credit. The candidate has some correct concepts, for example, the idea of energy lost from uneaten food, but the context is incorrect and suggests that the sardines will lose more energy.

(ii) Common seals and orcas are endotherms.

Sardines are ectotherms.

Explain why the transfer of energy from sardines to orcas is less efficient than the transfer of energy from zooplankton to common seals.

(3)contil · Echlerms rely on environment to obbes boly weat. frely heat Knough End-thermy produce only on exollemic nehulic rachins (prespiration) Common seals are adollerns & love lots of erry a much higher nephblic rate (love 41 have Browled) so Regy franifir less efficient 4) Sarding ergy to anvi-apent 1050 1231 a er store retublic ste nih ۵



This strong answer gained all three marks. The candidate correctly states that endotherms will lose more heat, have to regulate their body temperature (and ectotherms do not), and so have a higher metabolic rate. (ii) Common seals and orcas are endotherms.

Sardines are ectotherms.

Explain why the transfer of energy from sardines to orcas is less efficient than the transfer of energy from zooplankton to common seals.

(3) Dears there are use energy in the maintain ence of a stable internal temperature + so release heat to the surrounding . not all is transferred to orcas as exercise Sears excrete energy as faces from sardines + the orca does not then digested an of the span Sear Sardines do not need to use energy From 700 pignicton to maintain temperature



This answer gained all three marks. The candidate has stated that seals regulate their body temperature and lose more heat. They also explain that there is energy loss from excretion.

Question 9 (c)(i)

This question asked candidates to define the term net primary productivity. Most candidates were able to gain the mark, often by giving the formula for NPP (NPP = GPP-R).

(c) Scientists investigated the impact of global warming on marine productivity.

They determined the effect of temperature and light intensity on the net primary productivity (NPP) of phytoplankton.

Phytoplankton were exposed to different light intensities at three different temperatures for one month. After one month, the scientists measured the increase in dry biomass of phytoplankton.

The results are shown in the table.

Light intensity	Mean increase in dry biomass of phytoplankton/g			
/arbitrary units	10°C	20°C	30°C	
5	4	6	2	
10	8	10	4	
15	10	20	15	
20	12	24	28	
25	12	28	35	

(i) State what is meant by the term net primary productivity (NPP).

(1)

energy available for next trophic level



(c) Scientists investigated the impact of global warming on marine productivity.

They determined the effect of temperature and light intensity on the net primary productivity (NPP) of phytoplankton.

Phytoplankton were exposed to different light intensities at three different temperatures for one month. After one month, the scientists measured the increase in dry biomass of phytoplankton.

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5	4	6	2	
10	8	10	4	
15	10	20	15	
20	12	24	28	
25	12	28	35	

The results are shown in the table.

(i) State what is meant by the term net primary productivity (NPP).

army andubility is the total net every gradued per go moss with an time. NOP = G-OP-R net primary productivity = gross primary productivity - Regpiration.



This is another example of an answer that gained one mark for correctly defining NPP using the formula.

Question 9 (c)(ii)

This final question on the paper required candidates to analyse a statement about the effect of fossil fuel use on orca populations. They were required to draw together information from an experiment into the effect of light intensity and temperature on the growth of algae with their own knowledge and the food chain given in the question. Stronger answers stated that the data showed that NPP generally increased with temperature, but at lower light intensities the NPP decreased when temperatures were higher. This suggests that at low light intensities, respiration increases but photosynthesis is limited. High quality answers described the patterns shown by the experimental data and linked them to other information in the question, such as an increase in cloud cover causing a decrease in light intensities, reducing NPP lower at higher temperatures. Strong answers also referred to the reduced availability of nutrients such as nitrates limiting protein synthesis. To reach Level 3, candidates needed to describe the data patterns, give explanations about how an increasing temperature could increase and / or decrease NPP (and the impacts on the food chain), and discuss the role of fossil fuels in the process. Weaker answers tended to be either purely descriptive or gave consequences of global warming without linking it to the data.

- *(ii) Some effects of global warming include the following:
 - Atmospheric carbon dioxide could cause an increase in temperature.
 - Increased atmospheric temperature could increase cloud cover.
 - Increased ocean temperature could reduce the movement of nutrients such as nitrates from the seabed to the surface water.
 - The scientists concluded that if the use of fossil fuels is not reduced, there
 will be a fall in populations of orcas in the South Atlantic Oceans.
 - Analyse the data in the table and the information given to discuss this conclusion.

(6) increases mean Sun ac proma NM nored enerm NZIMES Dave the Juller a rale. peraline a Ma enzymi 0 The produce yels temperature Nica M Philopla mes der no 71 ora DALL



- *(ii) Some effects of global warming include the following:
 - Atmospheric carbon dioxide could cause an increase in temperature.
 - Increased atmospheric temperature could increase cloud cover.
 - Increased ocean temperature could reduce the movement of nutrients such as nitrates from the seabed to the surface water. - Jless nutrients
 - The scientists concluded that if the use of fossil fuels is not reduced, there will be a fall in populations of orcas in the South Atlantic Oceans.

(6)

 Analyse the data in the table and the information given to discuss this conclusion.

- Buining Fossil Fuels causes co2 to be released
- The increased temperature alone would be
beneficial to the biomass of phytoplantion
as at over 20°C the biomass decreares
except in very high light intensity
to due to enzyme, starting to dinature
- The increased temp could increase cloud
cover which would decreat light intensity
Lo this would decreak the biomass
as loss photosynthesis could take place
this would reduce the amount of
energy passed to up me food chain to the
orcas and could decreate + population
-Less nutients in the sea bed means less nutrients
for the phytoplankton which would decican
- Experiment needs to be repeated many times to Validity the (Total for Question 9 = 15 marks)
- Experiment needs to be done on TOTAL FOR PAPER = 90 MARKS orca population to see if this (hange).



This answer gained six marks and is Level 3. The candidate gives descriptions of the data, gives explanations and links their answer to fossil fuel usage, also considering validity.

- *(ii) Some effects of global warming include the following:
 - Atmospheric carbon dioxide could cause an increase in temperature.
 - Increased atmospheric temperature could increase cloud cover.
 - Increased ocean temperature could reduce the movement of nutrients such as nitrates from the seabed to the surface water.
 - The scientists concluded that if the use of fossil fuels is not reduced, there
 will be a fall in populations of orcas in the South Atlantic Oceans.
 - Analyse the data in the table and the information given to discuss this conclusion.

Fossil fuel usage increases global warping as more (6) As global warming causes on increase in temperature due to On the mean increase of dry were biomass of phytoplanktan reduces such as from 42 to 2g over a 20°C increase in knoenture. Therefore mere is less phyroplankton, so areas fewer soopantition sording and seals surve as less food. Therefore orcas have loss good so they fall in population. to mare con results in high resperatives such cause high claud cover so toos caver right intensity . As light intensity reduces from 25 to 5 au, phytoplankkin biomass reduces by 33 33g at 30°C so laves biomass of phytoplanktur means less good has areas the to he hood chain. The higher see temperatures also cause Uss not mineral ions such as nitrated to move to Surface water, where 200plankton grow. So may have keves nitrates for protein synthesis so grow less and less likely to reproduce and furnice. So lover biomass of zooplankton reduces food for seals so less food for orcas so heir population declines (Total for Question 9 = 15 marks)



This answer gained six marks. Descriptions of the data, possible explanations and a link to fossil fuel are given making the answer Level 3.

- *(ii) Some effects of global warming include the following:
 - Atmospheric carbon dioxide could cause an increase in temperature.
 - Increased atmospheric temperature could increase cloud cover.
 - Increased ocean temperature could reduce the movement of nutrients such as nitrates from the seabed to the surface water.
 - The scientists concluded that if the use of fossil fuels is not reduced, there
 will be a fall in populations of orcas in the South Atlantic Oceans.
 - Analyse the data in the table and the information given to discuss this conclusion.

(6) The ch atn fall dissid Almost could cause cloud and incrosed 0 3000 and Ac Emp color low uy NPP of arbelogy units 5 pla AS poschle 6west production these 4 con an colded he stom well (zoopla secondary arsumers u rogentation and will reduce effect the same have ond readers Jordines such us am population of co AS m ill have Oras population Se concurron ((Total for Ouestion 9 = 15 marks) full in my see a



This answer gained two marks. The candidate has explained the consequences of global warming but unfortunately has not linked this to the experimental data or the use of fossil fuels, keeping the answer in Level 1.

- *(ii) Some effects of global warming include the following:
 - Atmospheric carbon dioxide could cause an increase in temperature.
 - Increased atmospheric temperature could increase cloud cover.
 - Increased ocean temperature could reduce the movement of nutrients such as nitrates from the seabed to the surface water.
 - The scientists concluded that if the use of fossil fuels is not reduced, there
 will be a fall in populations of orcas in the South Atlantic Oceans.
 - <u>Analyse the data</u> in the table and the information given to discuss this conclusion.

(6)

Hennicy an increase in claud ever means that there is quipplo be less light, as the should be e cleareds, and in the ight intenden causes read in buinass of phylydenckken, und Mangan icruse in temperature means that there is gain be the hear and a the kette it chines that hegher heart temperatives with untersity 25 60 curses a derease in brancess of phylophentons. Bith of it these equils we reduce the ament of physicalans there are which is demontal the food cheme as of there isn't any producer arguinsme then the athrancing here rething to fred in arcas) , Leaena to the extenden of orcas and other (Total for Question 9 = 15 marks)



This answer gained four marks and is Level 2. The candidate gives descriptions of the data and explanations of the impacts but does not link this with fossil fuel or discuss validity.

Paper Summary

Based on their performance on this paper, candidates should:

- Be fully familiar with the requirements of all the command words.
- Practice data analysis using unfamiliar sets of data prior to the examination.
- Explore all aspects of data presented in longer questions.
- Make sure that they use accurate and precise scientific vocabulary.
- Make sure that they work at an even pace throughout the exam. Focus on mark allocations for questions rather than trying to fill every line.
- Consider the validity of investigations when tackling longer discussion and evaluate questions.

Grade boundaries

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