




**T Level Technical Qualification in
Agriculture, Land Management
and Production: Crop, Woodland
and Horticulture**



**8717-031 Core: Paper 2
Exam guide**

Version 1.0

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1. Introduction

This exam guide for the T Level Technical Qualification in Agriculture, Land Management and Production: Crop, Woodland and Horticulture, Core: Paper 2 provides general tips for candidates taking this assessment, along with examples of different types of questions that will appear. Example candidate responses have also been provided along with examiner commentary and further hints and tips. The example candidate responses should not be considered as the only or best way to answer the question; their aim is to support transparency of the expectations when candidates are responding to different types of questions.

Marks, as indicated by “(1)” in red, have been added to show where marks have been awarded to support transparency of marking; they were not part of the candidate’s response. Where questions are marked using banded descriptors, individual marks are not indicated in this guide.

2. General Tips

- Spelling, Punctuation and Grammar (SPaG) are not assessed within the core exam; no marks are awarded or deducted based on this. Examiners will make a judgement in relation to phonetic spelling to determine if the candidate has the required knowledge and/or understanding and where there is credit will award the mark(s).
- Handwriting quality: It is essential that candidates provide responses that are clear and legible. Since examination papers are scanned and marked onscreen, ensuring legibility is crucial for accurate marking. Candidates should use a ball-point pen and take care that their handwriting is easy to read. A recommendation would be to use block capitals if handwriting is poor or explore using a scribe.
- It is key that candidates understand the paper is split into two sections (Section A and Section B) and they understand the type of questions they will find in each part of the paper. This can help them with time management ensuring they leave sufficient time to respond to the Extended Response Questions within Section B.
- The order of the paper is modelled in such a way that it gradually increases in level of difficulty. The paper starts with Section A with questions assessing knowledge, before moving onto understanding, then application. Section B then assesses application, analysis and evaluation.
- It is important that candidates carefully read and understand the question, reading it through twice if needed.

3. AO1a – Demonstrate Knowledge

What this assessment objective means

Recall or recognition of specific elements of knowledge which must be committed to long term memory in order to underpin success in the role.

All Assessment Objectives require the ability to recall knowledge. AO1a refers to instances where the candidate is simply required to demonstrate basic recall. In the exam, this helps to give confidence in sufficiency of coverage of the content, and recognises that not all knowledge requires further understanding eg terminology, number facts etc.

A candidate can

- name or recognise technical terms, principles or theories, based on a description/use or vice versa
- distinguish between correct and incorrect definitions/descriptions
- correctly use terminology/terms
- locate a part on a diagram.

This is assessed within the examination by

Simple questions that require knowledge that could be learned by rote (facts) with no requirement to go beyond recall and statement of fact:

- Labelling a diagram with names/locations
- Definitions, facts, recall of purpose of something
- Description of physical appearance of something.

3.1. Question and Mark Scheme

Q3	Stem	Define the term 'biosecurity'. (2 marks)
	Acceptable answer(s)	
	<ul style="list-style-type: none"> Measures aimed at preventing the introduction and/or spread of harmful organisms to animals and plants (1) in order to minimize the risk of transmission of infectious disease. (1) 	Award 1 mark for each correct statement up to a maximum of 2 marks . Credit any other appropriate response.
Total marks	2 marks	
AO	AO1a	
Specification reference	3.1 Principles of biosecurity in the crop production, trees and woodland, and horticulture and landscaping sectors.	

3.2. Candidate Responses

Example 1 (Marks 2)

Biosecurity is a series of measures to prevent the spread of pest and diseases from one place to another (1) and to decrease the chance of pests and diseases being taken to other places. (1)

Examiner Commentary on application of mark scheme

The candidate has identified two correct interpretations of the acceptable answer and has been awarded maximum marks.

Example 2 (Marks 1)

The practice of ensuring that plants are protected from harmful pests and diseases. (1)

Examiner Commentary on application of mark scheme

The candidate has made one correct response but has not provided a second point, hence gaining one mark only.

3.3. Examiner Hints and Tips

- Where candidates struggle to achieve marks in relation to AO1a, this is because they may not have the knowledge the question is targeting, meaning they do not have a secure breadth of knowledge across the syllabus. Candidates may either leave the question blank or will recall an incorrect fact, acronym or name.
- Candidates sometimes pick up on key words and capture knowledge around this. They should be encouraged to read the full question and ensure they are answering this accurately.
- When asked to recall legislation or regulations, examiners will accept industry recognised abbreviations and acronyms, as shown in the marking scheme. Candidates do not need to provide the date of the legislation to be awarded with the mark.
- Examiners will also accept alternative answers and wording, if acceptable within the marking guidance. For example, descriptions of terms.
- Where a candidate does not know the answer, or is unsure, they should be advised to leave these questions and come back to them once they have completed the rest of the paper.
- As per the guidance at the top of the paper, examiners will only accept the first two responses (if two answers are required) for marking. It was common for candidates to list multiple answers with the correct answer at the end of this list. It is important for candidates to understand that only the required number of responses will be marked.

4. AO1b – Demonstrate Understanding

What this assessment objective means

The ability to explain principles and concepts beyond recall of definitions in order to be able to transfer these principles and concepts between contexts. Candidates have built connections between related pieces of knowledge.

AO1b focuses on the ability of the candidates to show understanding by summarising or explaining concepts in their own words, exemplifying or comparing and making inferences in general terms that show, for example, cause and effect.

A candidate can

- explain a concept in their own words
- explain what it means in practice
- describe a process
- describe how something has an impact on another
- give relevant examples
- say what the impact/implication may be in general terms

This is assessed within the examination by

Straightforward questions requiring demonstration, beyond recall, of understanding about something. Response is in general terms, or a concrete exemplification.

- Why is...?
- What does ... mean?
- Give an example of how...
- Describe how...
- Explain the use of...
- Explanation of how something works
- Explanation of the benefits/weaknesses of...

4.1. Question and Mark Scheme (Describe the differences)

Q5a	Stem	Describe two differences between sexual and asexual reproduction in plants. (2 marks)
	Acceptable answer(s)	
	<ul style="list-style-type: none"> • Sexual reproduction requires two parent organisms / pollination and fertilisation, while asexual reproduction involves only one parent. (1) • Sexual reproduction requires flower structures whereas asexual reproduction uses vegetative propagation. (1) • Sexual reproduction introduces genetic variation but asexual reproduction results in offspring that are usually genetically identical to the parent. (1) • Asexual reproduction generally allows for faster production of plants compared to sexual reproduction. (1) • Asexual reproduction produces new organisms without a seed stage while in sexual reproduction, seeds are mandatory for the production of offspring. (1) 	Marking guidance Award 1 mark for each developed comparison that includes sexual and asexual reproduction, up to a maximum of 2 marks . No marks for any statement that does not compare the two. Credit any other appropriate response.
Total marks	2 marks	
AO	AO1b	
Specification reference	5.3 The life cycle of plants.	

4.2. Candidate Responses

Example 1 (2 marks)

Asexual reproduction means the offspring will be genetically identical to the parent whereas sexual isn't because there's two sets of DNA which introduce variation. (1) Asexual is a single organism reproducing whereas sexual requires two for pollination. (1)

Examiner Commentary on application of mark scheme

The candidate has made two clear comparisons that are in line with the statements in the mark scheme in the response. Each response has a comparative description of both processes, and hence gains maximum marks.

Example 2 (1 mark)

Sexual reproduction is where plants can reproduce when pollinated but asexual reproduction is when a plant can reproduce on its own. (1)

Examiner Commentary on application of mark scheme

The response from the candidate provides only one comparison and as such only gains one mark.

4.3. Examiner Hints and Tips

- In questions such as this, candidates should demonstrate their understanding by linking and comparing two areas of knowledge, eg characteristics of two types of reproduction. By just listing one characteristic with no comparison, candidates will not be able to achieve a mark as they have not demonstrated they understand how the characteristics differ. Using this model and interpretation of the mark scheme, candidates can understand how to structure their answer.
- Candidate should link their responses against the question context and requirements specifically.
- Candidates must ensure they have also considered the context given within the question. Candidates will only achieve full marks when they identify two differences relevant to the context given.

4.4. Question and Mark Scheme (Explain)

Q8b	Stem	Explain one function of roots. (2 marks)
	Acceptable answer(s)	
	<ul style="list-style-type: none"> Anchorage / lateral support roots / buttress roots grow to support the plant in the ground / provide stability (1) so it does not fall over / to ensure future growth. (1) Nutrient uptake to allow plants to take up essential components (1) to enable growth, leaf / fruit / seed production. (1) Water uptake to maintain turgor (1) to fully support the processes of the plant. (1) Storage of carbohydrates to enable perennation of the plant (1) to ensure survival through the dormant season. (1) 	<p>Award 1 mark for each basic explanation, and award 1 further mark for a developed explanation, to a maximum of 2 marks.</p> <p>Award a maximum of 2 marks for one function that is fully explained.</p> <p>Credit any other appropriate response.</p>
Total marks	2 marks	
AO	AO1b	
Specification reference	5.1 The physical structures of plants and their functions.	

4.5. Candidate Responses

Example 1 (2 marks)

*One function of the roots is anchorage to hold the plant up **(1)** which protects it from falling over in things such as strong winds. **(1)***

Examiner Commentary on application of mark scheme

The candidate has identified “anchorage” as a function and given a basic explanation of “to hold the plant up” and is awarded the first mark for this. The further/developed explanation is

provided in “to protect it from falling over....”, as in the acceptable answers, for the second mark.

Example 2 (1 mark)

A function of the roots is to absorb water and minerals for the plant to use. (1)

Examiner Commentary on application of mark scheme

The candidate has identified one function in “a function of the roots is to absorb water and minerals” and gave a basic explanation in “for the plant to use” for one mark. A further/developed explanation was not provided for a second mark.

4.6. Examiner Hints and Tips

- In questions such as this, candidates should take the approach of stating their point, then expanding on why this is important in the context of the question posed, using connects such as ‘which’ or ‘so’ to show cause and effect.
- Candidates need to provide both a knowledge statement and basic explanation to be awarded the first mark, with the second mark being awarded for the further/developed explanation, ie statement + basic explanation **(1)** + further explanation **(1)**.
- Using this model and understanding of the mark scheme, candidates can understand how to structure their answer.
- Candidates must ensure they have also considered the context given within the question. Candidates will only achieve marks when they identify specific functions relevant to the context given, eg roots.
- By just listing out functions with no further explanation, candidates will not be able to achieve full marks as they have not demonstrated they understand what this function is used for/does.

5. AO2 – Apply Knowledge and Understanding to Different Scenarios and Contexts

What this assessment objective means

Using and applying knowledge and understanding of processes, procedures, generalisations, principles and theories to specified, concrete scenarios. AO2 is about being able to take the understanding of generalities (AO1b) and apply them to specific novel scenarios. It is more granular than the more extended synthesis/creation that may respond to an analysis (AO3a) of a more holistic complex scenario/brief.

A candidate can

- differentiate relevant from irrelevant information in a given, new scenario
- select appropriate procedures/principles from memory
- implement these procedures and principles appropriately for the given scenario.

This is assessed within the examination by

Given a clear, straightforward/narrow scenario, the question requires selection and application of relevant principles and procedures in a way that is specific to the scenario (rather than in general terms).

- What is the best approach to... in this scenario?
- Explain the process/procedure to take when...
- What are the implications of ... (specific rather than general scenario).

5.1. Question and Mark Scheme (AO2 Explain)

Q10	Stem	<p>A lorry load of containerised trees has arrived on site a day early, and mechanical lifting gear is not yet available. The lorry has to be manually unloaded immediately to avoid blocking traffic.</p> <p>Explain two risks for the staff of having to unload the trees in this situation.</p> <p style="text-align: right;">(4 marks)</p>	
		Acceptable answer(s)	Marking guidance
		<ul style="list-style-type: none"> • Having to lift trees out of the lorry will lead to risks of manual handling injuries (1) which could lead to future staff absence. (1) • The manual unloading and transport processes present risks of slips / falls / muscle strains / falling objects (1) due to size / weight of trees and lack of lifting gear. (1) • Staff could be put in a situation that could lead to physiological stress due to overexertion (1) due to the time pressure of having to unload immediately. (1) • The absence of planning and urgency of the task could result in the staff being subject to psychological trauma (1) which could jeopardise current and future tasks. (1) • Other vehicles could collide with staff members while trying to get by the lorry (1) leading to serious injury/more disruption. (1) 	<p>Award 1 mark for each basic explanation and award 1 further mark for each developed explanation up to a maximum of 2 marks.</p> <p>Award a maximum of 4 marks for two fully explained risks.</p> <p>Credit any other appropriate response.</p>
Total marks	4 marks		
AO	AO2		
Specification reference	1.1 Hazards, risks and control measures associated with working in the crop production, trees and woodland, and horticulture and landscaping sectors.		

5.2. Candidate Response

Example 1 (4 marks)

A big risk is they may hurt themselves and cause damage to their backs from lifting trees (1) and have to have time off. (1)

Another risk is that traffic may try to overtake the lorry. This could result in the staff being hit by traffic (1) and seriously hurt. (1)

Examiner Commentary on application of mark scheme

The candidate provided two acceptable answers with basic and developed explanations, achieving the full 4 marks.

The first response identified a risk in “they may hurt themselves / cause damage to their backs” with a basic explanation for this in “from lifting trees” for the first mark, and a further explanation in a further consequence of this, “and have to take time off” for the second mark.

The second response identified a risk, “traffic may try to overtake the lorry” and a basic explanation, “could result in the staff being hit by traffic” for a third mark, and a further explanation, “and seriously hurt”, for a fourth.

Example 2 (3 marks)

The first risk is that the lorry is in a road and is causing traffic which can injure the staff unloading/pedestrians/cyclists. (1)

The second risk is manual handling as someone could get injured when moving trees (1) as they are heavy and could be dropped (1) or simply too heavy and could pull a muscle.

Examiner Commentary on application of mark scheme

The candidate received 1 mark for the first response and 2 marks for the second.

In the first response, they gave a knowledge statement in “the lorry is in the road and is causing traffic” and a basic explanation in “which can injure the staff unloading/pedestrians/cyclists”, but did not offer a further/developed explanation, for example a further consequence of this.

In the second response, the candidate identified “manual handling” as a risk and gave a basic explanation by saying that “someone could get injured when moving trees”. A further explanation was given in “as they are heavy and could be dropped”. No further marks were available for the additional further explanation provided in “or simply too heavy and could pull a muscle”.

5.3. Examiner Hints and Tips

- In questions such as this, candidates should take the approach of stating their point, then expanding on why this is important in the context of the question posed, using connects such as 'which' or 'so' to show cause and effect.
- Candidates need to provide both a knowledge statement and basic explanation to be awarded the first mark, with the second mark being awarded for the further/developed explanation, ie statement + basic explanation **(1)** further explanation **(1)**.
- Using this model and understanding of the mark scheme, candidates can understand how to structure their answer.
- Any context given to the candidates is needed to answer the question in full. It is crucial candidates acknowledge this context in their response and tailor their knowledge to this context.
- Candidates should be encouraged to highlight or underline the context given within the question. They should consider how this context impacts on the question they are being asked. They will only be given context and information which is relevant and needed for them to answer the question.
- Candidates should clearly link their responses against the question context and requirements specifically.

5.4. Question and Mark Scheme (Bridging Question)

Q12	Stem	<p>A new land-based business is concerned about the risks to their employees of hand arm vibration syndrome (HAVS)/white finger.</p> <p>Explain how they can implement the hierarchy of control measures to minimise these risks.</p> <p style="text-align: right;">(6 marks)</p>	
	Levels of Response		
	Band	Marks	Descriptor
	3	5-6	Demonstrates thorough application of knowledge and understanding of how the hierarchy of control measures can be applied to minimise the risks of hand arm vibration syndrome (HAVS)/white finger. Reasonings for the measures are highly detailed and relevant.
	2	3-4	Demonstrates good application of knowledge and understanding of how the hierarchy of control measures can be applied to minimise the risks of hand arm vibration syndrome (HAVS)/white finger. Reasonings for the measures are mostly detailed and relevant.
1	1-2	Demonstrates basic application of knowledge and understanding of requirements how the hierarchy of control measures can be applied to minimise the risks of hand arm vibration syndrome (HAVS)/white finger. Reasonings for the measures has limited detail and relevance.	
	0	No relevant material	
Indicative Content			
<ul style="list-style-type: none"> • Elimination by redesigning the job. This may involve removing the source of vibration or substituting it with a less hazardous one. For example, using a hydraulic breaker instead of a hand-held breaker to break concrete. • Substitution by replacing the process with different equipment/machinery or more up to date equipment that has been designed to minimise vibrations. 			

	<ul style="list-style-type: none"> • Engineering controls would involve modifying the equipment or the work environment to reduce exposure to vibration. For example, using anti-vibration gloves or mounting the equipment on vibration-absorbing materials. • Administrative controls by implementing training, certification, safe working practices, risk assessments and discipline and this could involve changing the way work is done to reduce exposure to vibration. For example, rotating workers between jobs that involve vibration and those that do not. • Monitoring time used and adhering to duration of use recommendations. • Personal protective equipment - where the risk cannot be sufficiently controlled using the above measures use appropriate PPE and protective equipment. This involves using PPE to reduce exposure to vibration. For example, using antivibration gloves or using tools with lower vibration levels. • Employers should prioritise the first two measures and only use administrative controls and PPE when the first two measures are not feasible. • Employers should also monitor the effectiveness of the control measures and review them regularly.
Total marks	6 marks
AO	AO2
Specification reference	1.1 Hazards, risks and control measures associated with working in the crop production, trees and woodland, and horticulture and landscaping sectors.

5.5. Candidate Response

5.5.1. Band 3

Top of band 1 response (6 marks)

The hierarchy of risk approach prioritises different strategies from most to least effective in this case to reduce exposure to hand-arm vibration.

Elimination removes the hazard entirely by using alternative methods that do not involve vibration. For example, instead of using a hand held jackhammer, consider using hydraulic or pneumatic tools that produce less vibration.

Substitution is the next step in the hierarchy, in this case by replacing high-vibration tools with those designed to produce less vibration. For instance, use anti-vibration tools or those with built-in vibration dampening features.

Engineering Controls are the third step and an example would be to modify equipment to reduce vibration exposure. This can include adding anti-vibration handles or dampeners to tools. Another example would be the regular maintenance of tools and equipment to ensure they are in optimal condition and produce minimal vibration.

Administrative Controls are the fourth step and would work to limit exposure time by rotating tasks among workers to reduce the duration each worker is exposed to vibration or by training and education to ensure workers understand the risks and proper use of tools to minimise vibration exposure.

Personal Protective Equipment (PPE) is considered the final step of the hierarchy and in this case would include using anti-vibration gloves to help reduce the impact of vibration on the hands and ensuring proper clothing to keep hands warm and dry, as cold and wet conditions can exacerbate the effects of vibration.

By following these steps, the risk of HAVS would be reduced and you would protect workers from the harmful effects of hand-arm vibration

Examiner Commentary on application of mark scheme

The candidate has demonstrated a thorough and logical application of knowledge and understanding of how the hierarchy of control measures can be applied to minimise the risks of hand arm vibration syndrome (HAVS)/white finger. They provided a correctly sequenced response covering all areas of the hierarchy stated in the mark scheme, with reasonings, for each of the measures, which are highly detailed and completely relevant to the scenario.

5.5.2. Band 2

Top of band 2 response (4 marks)

The business can eliminate the use of any vibrating tools for jobs that can be done using alternative tools that do not have the risk of causing the operator to develop white finger when tools that can cause white finger are required.

The business can enforce a policy that they are only used by the same person for short periods of time with frequent breaks to minimise the chance of developing white finger. This could be done by workers alternating who is resting and who is using the equipment or just by one employee taking regular breaks. Wearing appropriate PPE when using the equipment can also help to lower the chance of developing white finger.

Examiner Commentary on application of mark scheme

The candidate has demonstrated a good application of knowledge and understanding of how the hierarchy of control measures can be applied to minimise the risks of hand arm vibration syndrome (HAVS)/white finger. The first statement can be interpreted as covering elimination

and substitution (the candidate refers to “alternative tools”) and also engineering controls. The “enforce policy” is an administrative example. Reasonings for the measures are mostly detailed and relevant but not fully expanded.

5.5.3. Band 1

Top of band 3 response (2 marks)

They could implement time restrictions so an employee can only use the tools for a specific duration of time and then they require a break. Another solution would be to have tools with AUS Cantr-vibration sprays and similar health and safety gadgets so that the chance of HAVS is minimal, meaning that the employees can use the tools for longer

Examiner Commentary on application of mark scheme

This candidate's response demonstrates only a basic and limited application of the knowledge and understanding of requirements of how the hierarchy of control measures can be applied to minimise the risks. The candidate has tried to explain how the system can be implemented to minimise risks by using examples, but they have not considered the full range of the hierarchy. Reasonings for the measures described have detail and relevance but the missing steps preclude a higher mark being awarded.

5.6. Examiner Hints and Tips

- Candidates should be encouraged to highlight or underline the context given within the question. They should consider how this context impacts on the question they are being asked. They will only be given context and information which is relevant and needed for them to answer the question.
- Candidates should link their responses against the question context and requirements specifically, trying not to respond randomly or interpret the question to fit a situation they may be familiar with, but which is not directly related to the question.
- To meet the “explain” criteria the candidate needs to provide reasonings for the measures which have detail and relevance.

6. Section B – Extended Response and AO3 (Analysis and Evaluation)

AO3a Analysis

What this assessment objective means

Complex thinking that distinguishes patterns and relationships, breaking material into constituent parts, and determining how the parts are related to one another and holistically, inferring underlying assumptions / conditions / relevance / causation.

It can be seen an extension of understanding (AO1b), or a prelude to evaluation (AO3b) and to the creation of a response to, for example, a complex brief or situation (more fully assessed in the project).

A candidate can

- break down a complex problem into parts
- consider the relationships between the parts
- manipulate knowledge and experience to determine a range of solutions/proposals
- balance competing priorities to suggest the best outcome.

This is assessed within the examination by

Given a relatively complex, realistic occupationally relevant scenario, stating a situation that implies (but does not directly state) the need for application of a number of different (possibly competing) principles / approaches / procedures; a requirement to respond / propose solutions

- Analyse the situation recommending an approach to be taken to...
- Analyse how the situation can be managed in order to...
- Analyse the consequences of...

AO3b Evaluation

What this assessment objective means

Ability to make judgements about the value, for some purpose, of own or other's work / ideas / solutions / methods using internal or external criteria or standards relevant for the occupational area. These criteria may include, for example, quality, accuracy, effectiveness, efficiency, coherence, consistency, and may be quantitative or qualitative.

A candidate can

- judge the quality of actions proposals, outcomes
- using their own internal quality standards
- using external standards / criteria
- can justify their judgements of quality.

This is assessed within the examination by

Must have something either given or supplied by the candidate to be evaluated; often following / as part of analysis and the proposal of, for example, an approach (AO3a above).

- ...justify your decisions/approach
- Evaluate how well ... meets ...standards
- Evaluate how effective/efficient...

6.1. Question and Mark Scheme

Q14	Stem	<p>A report has shown that the number of very hot days in the UK could become much more frequent in the near future.</p> <p>Analyse the potential effects of this on the physical and physiological processes in plants and evaluate how higher temperatures may impact the growth of crops, trees and woodland plants.</p> <p style="text-align: right;">(12 marks)</p>
Levels of Response		
Band	Marks	Descriptor
4	10-12	<p>Demonstrates comprehensive application of knowledge and understanding of the key physical and physiological processes in plants and the potential effects of increased temperature on the production of crops, trees and woodland plants.</p> <p>Demonstrates comprehensive use of analysis of the potential impacts of high temperature on the key physical and physiological processes in plants.</p> <p>Demonstrates comprehensive evaluative skills on how future higher summer temperatures may affect production of crop, trees and woodland plants. Evaluations are supported with highly detailed and relevant reasoning.</p>
3	7-9	<p>Demonstrates thorough application of knowledge and understanding of the key physical and physiological processes in plants and the potential effects of increased temperature on the production of crops, trees and woodland plants.</p> <p>Demonstrates thorough use of analysis of the potential impacts of high temperature on the key physical and physiological processes in plants.</p> <p>Demonstrates thorough evaluative skills on how future higher summer temperatures may affect production of crop, trees and woodland plants. Evaluations are supported with mostly detailed and relevant reasoning.</p>
2	4-6	<p>Demonstrates good application of knowledge and understanding of the key physical and physiological processes in plants and the potential effects of increased temperature on the production of crops, trees and woodland plants.</p> <p>Demonstrates good use of analysis of the potential impacts of high temperature on the key physical and physiological processes in plants.</p>

		Demonstrates good evaluative skills on how future higher summer temperatures may affect production of crop, trees and woodland plants. Evaluations are supported with some detail and relevant reasoning.
1	1-3	Demonstrates basic application of knowledge and understanding of the key physical and physiological processes in plants and the potential effects of increased temperature on the production of crops, trees and woodland plants. Demonstrates a basic use of analysis of the potential impacts of high temperature on the key physical and physiological processes in plants. Demonstrates basic evaluative skills on how future higher summer temperatures may affect production of crop, trees and woodland plants. Evaluations are limited with minimal detail and relevant reasoning.
	0	No relevant material

Indicative Content

Analyse the potential effects of high temperatures on the physical and physiological processes in plants

- Higher air temperatures would increase the rate of **photosynthesis**, which would lead to more leaf development and higher yields, but only if there was sufficient water, light and carbon dioxide available. Photosynthesis would be inhibited, and leaf development and yield would not increase if any of the other factors influencing the rate of photosynthesis were limited.
- Other factors influencing the rate of photosynthesis (light, chlorophyll, carbon dioxide, water, leaf colour) could be impacted. Higher temperatures would be associated with increased light intensity and duration, but higher temperatures will also lead to water shortage which will become a limiting factor. Carbon dioxide levels will continue to rise which will have a positive impact on photosynthesis, but only if all other factors are available.
- Higher temperatures would impact the function of guard cells and stomata in the leaves as an increase in temperature causes stomata to open which can lead to more water loss by evaporation and diffusion from leaves. This will impact water uptake from the roots.
- Higher temperatures will enhance the rate of cellular **respiration** because heat speeds up the reactions. Respiration is dependent on photosynthesis, as the process of respiration uses the glucose made during photosynthesis to make energy. This could become imbalanced due to respiration rates exceeding the synthesis of glucose by photosynthesis.
- Temperature affects plants' growth, especially in temperate crops like wheat. Higher temperature reduces the growth of shoots and roots in plants. This results in a substantial reduction in the overall height of the plant.

- The limiting factors of photosynthesis are carbon dioxide, water and sunlight, so these factors impact respiration too. Too much or too little of any of these inputs can reduce rates of both photosynthesis and respiration. These processes are interconnected, and the variables that affect them interact to impact plant growth.
- As respiration in plants increases with temperature increases, this can also cause an increased rate of transpiration. Too much transpiration can lead to too little water, which may reduce the rate of photosynthesis. When photosynthesis slows down, this can decrease the amount of sugars available for respiration.
- **The uptake, transport and loss of water and nutrients** is directly impacted by high temperatures. Higher temperatures would lead to increased water loss out of the stomata from plants due to more evaporation and diffusion. Increasing temperature increases the rate of transpiration because more heat energy means that the water molecules have more kinetic energy and will diffuse faster out of the stomata. Increase in temperature increases rate of evaporation, and also increases the amount of water the outside air can hold increasing the water potential gradient, increasing transpiration.
- High temperatures increase the demand for water vapour in the environment, which forces plants to transpire more water through the leaves. This leads to a higher leaf temperature and a reduction in photosynthesis.
- Higher temperatures can affect osmosis in plants by changing the rate of water movement across the cell membrane. As temperature increases, the rate of osmosis also increases. This increased movement can cause water to move across the cell membrane more quickly, which can lead to changes in cell volume and turgor pressure.
- However, the effect of temperature on water uptake and loss in plants is complex and depends on several factors such as humidity, light intensity, wind speed and soil moisture.
- Heatwaves cause trees to prematurely drop their leaves in an effort to preserve water. This is a mechanism that helps plants and trees preserve water.
- Higher temperatures will have both positive and negative effects on **plant tropisms**.
- Higher temperatures can have a negative impact on hydrotropism in plants. High temperatures and intense droughts can lead to excessive plant water loss.
- Heliotropism temperature mediates flower growth and development, pollen viability, and influences pollinator visitation.
- Phototropism effects may be altered, as a plant bends or grows directionally in response to light and this may be factor due to the association of high light and increased temperatures.
- Tree growth is stunted in warmer temperatures, so as global temperatures increase, forest tree growth could decrease.

Evaluate how high temperatures will impact the growth of crop, trees and woodland plants

- High temperatures could have a significant impact on the reproduction of crop, trees and woodland plants. Climate change-induced increases in the frequency of extreme weather events, particularly heatwaves, could become a serious threat to crop productivity. The productivity of grain crops is dependent on the success of sexual reproduction, which is very sensitive to heat stress.
- Increasing ambient temperature is the major climatic factor that advances flowering time in crops and other plants this causing synchronisation problems with pollinators or pollinating mechanisms.
- Drought (water deficits) and heat (high temperatures) stress are the prime constraints that severely reduce crop productivity and food security globally. High temperatures can affect seed and fruit set and development which would affect crop yields and harvest time and techniques. The extent of damage at the reproductive phase of crop growth, mainly the seed filling phase, is critical and causes considerable yield losses.
- High-temperature stress causes various physiological changes in crops during different growth stages, and germination is affected at the initial stage, with the impact of high temperature on seeds leading to decreased seed germination percentage, reduced plant emergence, poor seedlings vigour, abnormal seedlings, and decreased radicle and plumule growth which will impact on crop establishment and productivity.
- Heat stress will also affect the success of the vegetative reproduction processes used to propagate a number of horticultural crops due to excessive water loss from cuttings. This would lead to more expensive and advanced technical growth facilities being needed to meet the need for continual production of crops.
- High temperatures can negatively affect the various reproductive processes of plants such as pollen viability, germination of pollen grains, growth of pollen tube, positions of stigma and style, fertilisation.

Total Marks	12 marks
AO	AO2 = 4 marks AO3a = 4 marks AO3b = 4 marks
Specification reference	5.1 The physical structures of plants and their functions. 5.2 Physical processes involved in plant growth. 5.3 The life cycle of plants. 5.4 Growth and development of plants.

What do we mean by:

	AO2 Application	AO3a Analysis	AO3b Evaluation
Comprehensive	A range of detailed and accurate understanding that is fully relevant to the context or question. Detailed and accurate interpretation through the application of relevant knowledge and understanding,	Detailed and accurate analysis through the application of relevant knowledge and understanding.	Detailed and substantiated evaluation through the application of relevant knowledge and understanding. Detailed and substantiated judgement through the application of relevant knowledge and understanding.
Thorough	A range of accurate understanding that is relevant to the context or question. Accurate interpretation through the application of relevant knowledge and understanding.	Accurate analysis through the application of relevant knowledge and understanding.	Supported evaluation through the application of relevant knowledge and understanding. Supported judgement through the application of relevant knowledge and understanding.
Good	Some understanding that is relevant to the context or question. Some accuracy in interpretation through the application of some relevant knowledge and understanding.	Some accuracy in analysis through the application of some relevant knowledge and understanding.	Partially supported evaluation through the application of some relevant knowledge and understanding. Partially supported judgement through the application of some relevant knowledge and understanding.
Basic	Limited understanding that is relevant to the context or question. Limited accuracy in interpretation through lack of application of relevant knowledge and understanding.	Limited accuracy in analysis through lack of application of relevant knowledge and understanding.	Un-supported evaluation through lack of knowledge and understanding. Un-supported judgement through lack of application of knowledge and understanding.

6.2. Candidate Responses

6.2.1. Band 4

Top of band 4 response (12 marks)

All physiological processes in plant will be impacted by increased temperatures. The increased temperatures may also be associated with less rainfall. Photosynthesis, where light, carbon dioxide and water are used to synthesise oxygen and carbohydrates in the form of glucose will be affected and respiration, where the glucose is used to release chemical energy is, as is photosynthesis, enzyme dependent and thus highly influenced by temperature. Increased temperature will increase the rates of both these processes which will have significant impacts on resource use and growth rates.

The processes of water uptake, transport and loss via transpiration will be affected due to higher rates of evaporation via the stomata and potentially less water in the soil for uptake. Nutrient uptake, which in some cases is an active system, is also temperature dependent.

Higher temperatures may increase the rate of photosynthesis as long as the other factors (water and carbon dioxide) are not limited, but will be reduced and thus effecting crop yield and quality if any (such as water) are in short supply which is quite possible in high temperatures. Higher temperatures also impact water movement via transpiration, the rates will be increased in hot conditions due to the higher rates of evapotranspiration but on the other hand stomata could be closed due to temperature stress which would stop transpiration and ultimately photosynthesis due to the lack of water to the mesophyll cells.

Temperature also affects osmosis (water uptake through a semi-permeable membrane) into root hairs, across the cortex then via the endodermis into the xylem and too much uptake could cause internal disruption to root cortex cells and transport systems.

Respiration rates will increase with higher temperatures, as long as glucose and oxygen are available to the cells and could become imbalanced with the rates of photosynthesis causing poor growth and reproductive problems. There could be tropic imbalance as well as plants grow toward the light (phototropism) and higher light may lead to etiolation.

The impact on the growth of crops, trees and woodland plants could be significant. The risk of extreme weather events could seriously affect crop production. Anything that could imbalance reproduction, for instance the change in seasons or pollinator population would impact any crop that produces seeds such as the major cereal crops.

Drought at critical times will affect crop yield in a negative manner and cause issues with tree that may not be evident at the time. Flowering times could be impacted which would directly affect pollination and fertilisation rates and reduce yields. Germination rates could be affected by high temperatures of the soil and atmosphere leading to reduced emergence due to induced dormancy and reduced levels of crop production and quality.

Seed and fruit set are directly influenced by higher temperature which could cause lower yields, crop loss and shortage of planting material. In horticulture, high water loss will negatively impact all crops grown under glass and the cost of cooling the environment in glasshouse would be prohibitive. In woodland settings tree growth could be inhibited by lack of water and yield and quality of timber reduced, furthermore the risk of tree fall would be increased due to drought causing harvesting problems.

In conclusion, the increased frequency of higher temperatures will impact the growth of crops, trees and woodland plants due to the effect on the processes of water uptake, photosynthesis and respiration which are fundamental to crop growth and quality. The additional effects on reproduction, especially pollination and fertilisation, are likely to be significant both economically and environmentally

Examiner Commentary on application of mark scheme

The candidate has composed a comprehensive, detailed and accurate application of knowledge and understanding of the key physical and physiological processes in plants, fully relevant to the question, with all processes defined to reinforce evidence of understanding. The potential effects of increased temperature on the production of crops, trees and woodland plants are described with reference to key physiological and physical processes in comprehensive detail.

The candidate has described a detailed and accurate analysis through the application of relevant knowledge and understanding across all areas with relevant examples and scenarios described. The range of issues associated with reproduction has been evaluated and contextualised with detailed and relevant reasoning.

The candidate has shown comprehensive evaluative skills on how future higher summer temperatures may affect production of crop, trees and woodland plants. Evaluations are supported with highly detailed and relevant reasoning.

The response is coherent and articulated using a logical structure, with clear comprehension, use of scientific terms and language and the work finished with a summary based on their evaluations and understanding.

6.2.2. Band 3

Top of band 3 response (9 marks)

In the future, if there is expected to be an increase in very hot days in the UK, this is usually also associated with very dry weather with infrequent amounts of rainfall. This could affect crop plants and tree growth, and their physical and physiological processes such as photosynthesis, respiration and transpiration.

Almost all food crops are annual plants, being sown, grown and harvested in the same year - apart from a few such as asparagus which can take up to three years to be ready to harvest. The issue with many crops (including cereal crops and vegetables) being annuals, and the risk of hotter, drier summers, is that crops may have altered growth patterns. They may also be ready to harvest much earlier, or much later, depending on climatic variations. If there is an especially dry spring, when many field and vegetable crops are establishing, there may be poor or restricted germination and establishment, and may lead to a requirement for irrigation to be applied. But watering entire fields is very expensive, especially if its constantly dry and hot for long periods of time and places demands on resources and environmental issues.

Hot and dry weather will also impact osmosis which is one of a plant's processes. Osmosis occurs in all plants, and is the movement of water from an area of high concentration, to an area of low concentration, through a semi permeable membrane, in plants this is water from the soil into a plants roots, and then transported up into the stem and leaves of the plant.

However, if it has been dry for a very long time, then the opposite may begin to happen, and water will begin to be drawn out of a plant into the dry soil, causing the plant to wilt, and eventually die if there is no rainfall or left unwatered. This would affect plants with shallow roots first, such as crops and grasses (it's common most years in the UK for lawns to turn yellow in summertime as their roots are very shallow, and there's no water for them to use for photosynthesis or transportation and therefore the grass dies), and lastly effect plants with deep roots, such as trees. Photosynthesis and respiration would also be affected, as high temperatures would increase the rate, but water may be in short supply and so cause poor growth and negative effects on plant development.

Consequently, more hot and dry days will disrupt plants growth and eventually slow the growth of larger plants such as trees, and it will effect all plant processes as water is necessary for all them, such as photosynthesis and transpiration. These factors will all impact plants growth and establishment patterns and yield and make it more difficult to grow crops, without human intervention.

Examiner Commentary on application of mark scheme

The candidate demonstrates a thorough application of knowledge and understanding of the key physical and physiological processes in plants with a good section on water uptake and understanding of the effects on photosynthesis, respiration and transpiration. The potential effects of increased temperature on the production of crops, trees and woodland plants are illustrated with some relevant and appropriate examples. Higher marks could have been obtained with more detailed descriptions and analysis of photosynthesis and respiration.

The candidate demonstrates some thorough evaluative skills on how future higher summer temperatures may affect production of crop plants and makes reference to the effects on trees and woodland plants. The evaluations are supported with mostly detailed and relevant

understanding and reasoning. The conclusion could have been developed further with more detailed evaluation to obtain higher marks.

6.2.3. Band 2

Top of band 2 response (6 marks)

All crops and plant have preferences on heat and temperature in order for growth. Generally, crops do not grow well in temperatures too cold or too hot. One potential effect on the physical and physiological process would be stunted growth of the plant, this is because extreme heat and dryness is a cause of drought which damages the soil, the ground dries up and cracks and the plant is unable to take up enough water for its needs. This also causes a scarcity within the nutrient availability for the roots of the crop. This will cause a stunt in the growth as roots will not be able to absorb much from the soil, especially key nutrients such as nitrogen. Not only would this affect cropping systems, but this would also cause newly planted woodland saplings or hedgerow whips difficulties in taking up water and finding nutrients to grow well and eventually effect established trees.

Another potential effect on the physical and physiological processes in plants from these higher temperatures would be scorching or burnt leaves, while sunlight is important for beneficial plant processes like photosynthesis, too much sunlight can be very dangerous to the health of the leaves and the overall plant health. This is because too much sunlight will cause the leaves on crops to burn, they will turn yellow and wilt. This damage to the chlorophyll in the plants leaf cells will block the process of photosynthesis from occurring at all, this will cause much damage to the plant and its growth and development. Also, like my previous points this will most definitely stunt the overall growth of the plant, not allowing it to grow steadily as it should and will affect respiration rates which will have another negative effect.

The problem which occurs because of the negative impacts of the plant growth will be a reduction of yield when it comes to the harvesting as the incompleteness of these plant processes will more than likely leave the plant unready for harvest and reduce yields and quality

Examiner Commentary on application of mark scheme

The candidate has written a structured response and shown some good understanding that is relevant to the context or question. They have outlined key physical and physiological processes in plants and the potential effects of increased temperature on the production of crops, trees and woodland plants which have all been considered, to some extent.

There is some accuracy in interpretation through the application of some relevant knowledge and understanding with some analysis of the potential impacts of high temperature on the key physical and physiological processes in plants, with chlorophyll and nitrogen being cited as specific examples.

The candidate has made some partially supported evaluation through the application of some relevant knowledge and understanding on how future higher summer temperatures may affect production of crop, trees and woodland plants and the potential problems. There is also some partially supported judgement through the application of some relevant knowledge and understanding and relevant reasoning such as the effects on leaves and chlorophyll.

6.2.4. Band 1

Top of Band 1 response (3 marks)

Due to hotter temperatures, crops may struggle to germinate and properly establish meaning farmers will have to implement measures to mitigate the effects of this. For example, farmers could use irrigation systems such as drip irrigation to keep the soil and plants hydrated. The farmers should be selective with what crops they chose to plant and grow. Farmers should avoid crops with an annual lifecycle and instead plant crops with a perennial or biannual lifecycles. This is because crops will have more established roots which allows them to reach the nutrients and water which is deeper in the soil allowing them to be a more reliable crop during hot conditions.

Examiner Commentary on application of mark scheme

The candidate has written a short response to this question, which demonstrates a basic application of knowledge and understanding of a limited number of key physical and physiological processes in plants; in this instance the candidate has alluded to germination, life cycles and the uptake and loss of water. They also included the potential effects of increased temperature and reduced water availability on the production of crops, trees and woodland plants.

There is limited accuracy in interpretation through lack of application of relevant knowledge and understanding due to the narrow range of this response. The last statement offers some limited evidence of a basic use of analysis of the potential impacts of high temperature on the key physical and physiological processes in plants.

Evaluations are limited with minimal detail and relevant reasoning and a number of key processes are not described.

6.3. Examiner Hints and Tips

- These questions are designed to differentiate candidates' performance; they assess higher order thinking skills and as such they do stretch and challenge candidates.
- It is key that candidates give themselves sufficient time to respond to these lengthier questions.
- Although these questions appear in Section B, candidates can choose to tackle the extended response questions first before returning to Section A if they are concerned about their time management.
- Before writing out in full their answer to extended questions, candidates may find it helpful to identify the key requirements of the question and note down a brief plan or outline of how they will answer it. This will help clarify their thinking and make sure that they do not spend too much on or provide too much detail for one part of the question at the expense of others.
- By planning, candidates can ensure they provide a structure to their response and that they have covered off the major points they wish to make in their response. By considering the structure of the response, and how one point may link to another, they will be able to demonstrate both their ability to analyse and evaluate sufficiently to access the higher mark bands.
- There are always two elements to each ERQ and it is important that candidates focus on both elements equally to be able to move up into the higher bands. If candidates were asked to 'Analyse X and Justify Y', they need to attempt both of these elements. If a candidate provided a very comprehensive analysis of X, and did not provide any justification for Y, then the candidate may not be able to move out of Band 1 as they have not demonstrated understanding in both of the key areas.
- Candidates will not receive more marks if they make the same point multiple times.
- Candidates need to ensure their answers balance the ability to demonstrate a breadth of knowledge, ie making multiple points, against ensuring they demonstrate their depth of understanding on the subject matter. If candidates recall or list lots of points but fail to demonstrate the ability to evaluate and analyse these points, they will be marked into the lower bands. Likewise, if they only explore one point in extensive detail, they will not demonstrate they have sufficient breadth of knowledge of the subject area and will not be able to access higher bands.
- Candidates should be encouraged to write in continuous prose. A bullet point list will demonstrate some knowledge, but it will not demonstrate to the examiner that the candidate is able to analyse or evaluate, therefore limiting them to the bottom of the lowest band.

- When making a point in response to the question the candidate needs to explain why they think this point is relevant to the question; this demonstrates their ability to make judgements and is therefore evidence of evaluation.
- Similarly to the AO2 questions, candidates will be given context within the question, and it is key that their answers are tailored to the context/scenario given. It is important they give examples which support the context given to demonstrate the application of their understanding.

Get in touch

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