

# T Level Technical Qualification in Agriculture, Land Management and Production: Land-based Engineering

**8717-032 Core: Paper 2**

**Exam guide**

**Version 1.0**

# Contents

<b>1. Introduction</b>	<b>2</b>
<b>2. General Tips</b>	<b>3</b>
<b>3. AO1a – Demonstrate Knowledge</b>	<b>4</b>
3.1. Question and Mark Scheme	5
3.2. Candidate Responses	6
3.3. Examiner Hints and Tips	6
<b>4. AO1b – Demonstrate Understanding</b>	<b>7</b>
4.1. Question and Mark Scheme	8
4.2. Candidate Responses	9
4.3. Examiner Hints and Tips	9
<b>5. Mathematical Questions (AO1b/AO2)</b>	<b>10</b>
5.1. Question and Mark Scheme	11
5.2. Candidate Responses	13
5.3. Examiner Hints and Tips	13
<b>6. AO2 – Apply Knowledge and Understanding to Different Situations and Contexts</b>	<b>15</b>
6.1. Question and Mark Scheme	16
6.2. Candidate Responses	17
6.3. Examiner Hints and Tips	18
<b>7. Section B – Extended Response and AO3 (Analysis and Evaluation)</b>	<b>19</b>
7.1. Question and Mark Scheme	20
7.2. Candidate Responses	26
7.2.1. Band 4	26
7.2.2. Band 3	27
7.2.3. Band 2	28
7.2.4. Band 1	29
7.3. Examiner Hints and Tips	30

## 1. Introduction

This exam guide for the T Level Technical Qualification in Agriculture, Land Management and Production: Land-based Engineering 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 essential 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 a way such 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

<b>Q 3</b>	<b>Stem</b>	State <b>two</b> control measures that can be put in place to minimise risks when dealing with oil.  <b>(2 marks)</b>
	<b>Acceptable answer(s)</b>	<b>Marking Guidance</b>
	<ul style="list-style-type: none"> <li>• Personal Protection Equipment/PPE (1)</li> <li>• Elimination (1)</li> <li>• Engineering controls (1)</li> </ul>	<p>Award <b>1 mark</b> for each control measure to a maximum of <b>2 marks</b>.</p> <p>Award <b>1 mark</b> for <b>one</b> example in place of the answers provided:</p> <p>PPE: (Nitrile) gloves/safety boots/overalls/safety glasses.</p> <p>Elimination: Working on a flat surface.</p> <p>Engineering controls: Use a drain tray/suitable container/hydraulic or pneumatic oil supply system.</p>
<b>Total marks</b>	2 marks	
<b>AO</b>	AO1a	
<b>Specification reference</b>	1.1 Hazards, risks and control measures associated with working in the land-based engineering sector	

## 3.2. Candidate Responses

### Example 1 (Marks 2)

*Gloves can be worn to reduce skin contact with oil (1) and use a funnel to reduce the likelihood of a spillage. (1)*

### Examiner Commentary on application of mark scheme

The candidate correctly recalled two control measures to minimise risk when dealing with oil. The candidate was awarded one mark for 'gloves' as an example of PPE and one mark for 'funnel' as an example of an engineering control.

### Example 2 (Marks 1)

*Use a drip tray when draining the oil (1), use spill kits if any is spilled.*

### Examiner Commentary on application of mark scheme

Candidate stated one correct control measure to minimise risk when dealing with oil. 'Drip tray' was awarded one mark. 'Spill kit' is a second example of an engineering control and therefore was not awarded a mark.

## 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.
- 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, if acceptable within the marking guidance. For example, descriptions of terms or definitions displayed via a formula.
- 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've 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 eg cause and effect.

### A candidate can

- explain a concept in their own words
- explain what it means in practice
- describe a process
- 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

<b>Q 9</b>	<b>Stem</b>	<p>Explain <b>one</b> example of how biosecurity can be improved in the working environment by wearing Personal Protective Equipment (PPE).</p> <p style="text-align: right;"><b>(2 marks)</b></p>
	<b>Acceptable answer(s)</b>	
	<ul style="list-style-type: none"> <li>• PPE/disposable footwear/boot covers act as a barrier to prevent harmful agents being carried on the soles of shoes <b>(1)</b> which prevents cross-contamination to vehicles/areas/buildings <b>(1)</b>.</li> <li>• PPE/disposable gloves act as a barrier to prevent harmful agents being carried (on the hands of an individual) <b>(1)</b> which prevents cross-contamination to areas/livestock/buildings/vehicles <b>(1)</b>.</li> <li>• PPE/disposable coveralls act as a barrier to prevent harmful agents being carried on clothes <b>(1)</b> which prevents cross-contamination to areas/livestock/buildings/vehicles <b>(1)</b>.</li> </ul>	<p>Award <b>1 mark</b> for a basic explanation, and award <b>1 further mark</b> for a developed explanation, to a maximum of <b>2 marks</b>.</p> <p>Award a maximum of <b>2 marks</b> for <b>one</b> example that is fully explained.</p> <p>Credit any other appropriate response.</p>
<b>Total marks</b>	2 marks	
<b>AO</b>	AO1b	
<b>Specification reference</b>	3.1 Biosecurity requirements and organisational policies.	

## 4.2. Candidate Responses

### Example 1 (2 marks)

*Biosecurity can be improved by using disposable PPE in the case of going to a site that has TB present (1) so it reduces the likelihood of cross contamination. (1)*

### Examiner Commentary on application of mark scheme

The candidate provided a full explanation of how biosecurity can be improved in the working environment by wearing Personal Protective Equipment (PPE). The candidate provided a statement ('using disposable PPE') and a basic explanation ('in the case of going to a site that has TB present') followed by further/developed explanation ('so it reduces the likelihood of cross contamination') to achieve the full marks available.

### Example 2 (1 mark)

*Wearing Personal Protective Equipment in the workplace can be beneficial as it can stop the spread of pathogens spread by animals, so if a technician has just come back from a callout, disposable PPE would have had to have been issued to him if the farm had any pathogens or disease. (1)*

### Examiner Commentary on application of mark scheme

The candidate provided a basic explanation of how biosecurity can be improved in the working environment by wearing Personal Protective Equipment (PPE). The candidate provided a statement ('it can stop the spread of pathogens spread by animals') and a basic explanation ('disposable PPE would have had to have been issued').

The candidate provided language within the answer which was repetitive of the stem, and this was not awarded marks.

## 4.3. 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/developed explanation (1).
- Candidates must ensure they have also considered the context given within the question. Candidates will only achieve marks when they identify examples or characteristics relevant to the context given.
- By just listing out examples or characteristics with no further or developed explanation, candidates will not be able to achieve full marks as they have not demonstrated they understand what this example or characteristic is.

## 5. Mathematical Questions (AO1b/AO2)

Paper 2 consists of a range of mathematical and scientific principles that underpin theories of land-based engineering.

There is no set amount of mathematical style questions or marks for each paper, but they will always feature as a part of the question paper therefore it is important candidates understand how the mark scheme works.

The questions will be as transparent as possible around what the candidate needs to demonstrate they know/understand.

For example, some questions may explicitly state the mathematical method we want to see (to assess understanding of that method) whereas others may need the candidate to determine the mathematical method from the context of the question (to assess ability to apply mathematical concepts to a particular context).

In some instances, candidates may be asked to provide the relevant unit of measure for their answers, whereas in other questions this may be given to the candidate on a response line.

Candidates will be told to show their workings where method marks are awarded.

## 5.1. Question and Mark Scheme

<b>Q 10</b>	<b>Stem</b>	<p>A tractor is to be fitted with four extra work lights. The combined resistance of the four lights is 1.5 Ohms and they are connected to a 12 Volt supply.</p> <p>a) State the formula used to calculate the current flowing within the circuit.</p> <p style="text-align: right;"><b>(1 mark)</b></p> <p>b) Calculate the current flowing within the circuit.</p> <p>Show your workings and provide the correct unit of measurement as part of your answer.</p> <p style="text-align: right;"><b>(2 marks)</b></p>	
	<b>Acceptable answer(s)</b>		<b>Marking Guidance</b>
	<p>a)</p> <ul style="list-style-type: none"> <li>• <math>I = V/R</math> (1)</li> <li>• Current is equal to voltage divided by resistance (1)</li> </ul>		<p>Award <b>1 mark</b> for the correct formula.</p> <p>Allow acceptable versions of the abbreviations.</p>
<p>b)</p> <ul style="list-style-type: none"> <li>• <math>12/1.5</math> (1) = 8 amps/A (1)</li> </ul>		<p>Award <b>1 mark</b> for demonstration of correct methodology.</p> <p>Award <b>1 mark</b> for a correct calculation <u>and</u> unit.</p> <p>Final answers must include units.</p>	
<b>Total Marks</b>	<p>a) 1 mark b) 2 marks</p>		
<b>AO</b>	<p>a) AO1b b) AO2</p>		

<b>Element</b>	6. Operating principles of integrated and stand-alone systems and components
<b>Specification reference</b>	6.10 Scientific laws used in land-based engineering.

## 5.2. Candidate Responses

### Example 1 (3 marks)

a)  $I = V/R$  (1)

b)  $I = V/R$

$I = 12/1.5$  (1)

$I=8$

$8A$  (1)

### Examiner Commentary on application of mark scheme

Mark 1: The candidate stated one of the two correct formulas that can be used to calculate the current flowing within the described circuit.

Mark 2: The candidate correctly calculated the answer using the formula stated in part a) and provided an answer which included the required unit of measurement. The candidate was awarded one mark for the correct method ('12/1.5') and one mark for an accurate answer with the correct unit of measurement ('8A').

### Example 2 (2 marks)

a)  $C = V/O$

b)  $C=V/O$

$C=12/1.5$  (1)

$C=8Amps$  (1)

### Examiner Commentary on application of mark scheme

Mark 1: The candidate did not state an accepted formula that can be used to calculate the current flowing within the described circuit.

Mark 2: The candidate correctly calculated the answer and provided an answer which included the required unit of measurement. The candidate was awarded one mark for the correct method ('12/1.5') and one mark for an accurate answer with the correct unit of measurement ('8A').

## 5.3. Examiner Hints and Tips

- Encourage candidates to always show their workings on mathematics questions. They may be able to pick up marks for following the correct method, even when calculations have gone wrong.
- If candidates only present an answer and do not show the method that they used for the calculation, they may not achieve full marks.

- Where candidates make errors in their calculations or the method used, they should cross through their workings.
- Candidates should note the unit of measure that their answer needs to be presented in.
- Candidates should note the number of decimal places or significant figures they are asked to give their answer to.
- Candidates should ensure any workings out are clear and are presented in a logical order.

## 6. AO2 – Apply Knowledge and Understanding to Different Situations and Contexts

### What this assessment objective means

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



## 6.1. Question and Mark Scheme

Q 12	Stem	<p>An agricultural dealership has taken on a new tractor manufacturer. The manufacturer's dealer standards state the dealership must maintain sufficient stock levels throughout the year.</p> <p>Explain <b>three</b> factors which may influence the stock levels of spare parts within the dealership.</p> <p style="text-align: right;"><b>(6 marks)</b></p>
	<b>Acceptable answer(s)</b>	
	<ul style="list-style-type: none"> <li>• Seasonal demand will increase sales of parts for particular machines due to increased usage at certain points in the year (1) which will require the dealership to supply parts quickly to meet the dealer standards criteria (1).</li> <li>• Weather conditions will impact the parts which require replacement due to load/wear/contamination (1) so the dealership will need to consider which stock will be required to meet customer demand (1).</li> <li>• Sales of machines will impact which parts are stocked so that the dealership can meet servicing needs/maintain warranty of machines (1) with dealer standards requiring parts stock to be held to meet workshop demand (1).</li> <li>• The level of machine use will influence component wear, leading to earlier replacements (1) which will place a requirement on the dealership to maintain stock to reduce down time (1).</li> <li>• The size of the dealership's stores will determine the quantity of parts which can be held at one time (1) meaning that the dealership may have to consider extra storage capacity/stock clearance sales to free up space (1).</li> </ul>	
	<b>Marking guidance</b>	
	<p>Award <b>1 mark</b> for each basic explanation, and award <b>1 further mark</b> for each developed explanation, to a maximum of <b>2 marks</b>.</p> <p>Award a maximum of <b>6 marks</b> for <b>three</b> factors that are fully explained.</p> <p>Credit any other appropriate response.</p>	
<b>Total marks</b>	6 marks	
<b>AO</b>	AO2	
<b>Qual spec reference</b>	4.2 Principles of stock management.	

## 6.2. Candidate Responses

### Example 1 (6 marks)

*Seasonal demand for parts may mean that stock levels may fall (1) during peak times such as mower blades in the spring and summer (1).*

*Political influence and conflict may lead to the loss of trade agreements (1) causing a shortage of parts (1), decreasing stock levels.*

*Environmental factors such as the destruction of factories through natural disasters may lead to a halt in production (1) which would cause stock levels to fall (1).*

### Examiner Commentary on application of mark scheme

The candidate provided a full explanation of three factors which may influence the stock levels of spare parts within the dealership in a given scenario.

The candidate's first explanation focused on seasonal demand providing a statement ('seasonal demand') and a basic explanation ('or parts may mean that stock levels may fall') followed by further/developed explanation ('during peak times such as mower blades in the spring and summer') achieving two marks.

The candidate's second explanation also achieved two marks ('political influence and conflict may lead to the loss of trade agreements causing a shortage of parts'). In this explanation the candidate gave another further explanation point; however, the mark scheme does not allow for three marks to be allocated to one explanation.

The statement 'decreasing stock levels' was awarded in the third explanation provided where it was repeated. The candidate's third explanation also achieved two marks.

### Example 2 (4 marks)

*Demand fluctuates depending on the time of year, this is due to different machines being used and worn out (1) which lowers the stock for these machines. (1)*

*Seasonal conditions could alter stock, as if it's a very hot summer more AC units and fans will be required. (1)*

*Popularity of certain brands or machines will greatly influence stock, as high use and high demand machines require more stock than a niche brand. (1)*

### Examiner Commentary on application of mark scheme

The candidate provided two basic explanations and one full explanation of factors which may influence the stock levels of spare parts within the dealership in a given scenario.

The candidate's first explanation provided a statement ('depending on the time of year') and a basic explanation ('due to different machines being used') followed by further/developed explanation ('which lowers the stock for these machines'), achieving two marks.

The candidate's second explanation consisted of a statement ('seasonal conditions/ if it's a very hot summer') and basic explanation ('more AC units/fans will be required'). The candidate was awarded the statement for 'seasonal conditions' or 'if it's a very hot summer' and not for both as 'summer' is an example of a season.

The candidate's third explanation provided a statement ('popularity of certain brands/machines') and a basic explanation ('high use and high demand machines require more stock').

The candidate did not provide a further/developed explanation for the second and third basic explanations provided and therefore missed out on the full two marks available for these answers.

### 6.3. 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/developed 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 link their responses against the question context and requirements specifically.

## 7. 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 eg 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 eg an approach, (AO3a above).

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

## 7.1. Question and Mark Scheme

<b>Q16</b>	<b>Stem</b>	<p>A customer has a tractor with an electro-hydraulically activated full-powershift transmission. The customer reports that the transmission is slipping when under load and travelling in a forward direction.</p> <p>Analyse how the operation of the components could cause the transmission system to malfunction and justify any tests of conformity.</p> <p style="text-align: right;"><b>(12 marks)</b></p>
<b>Levels of Response</b>		
<b>Band</b>	<b>Marks</b>	<b>Descriptor</b>
<b>4</b>	<b>10 – 12</b>	<p>Demonstrates comprehensive application of knowledge and understanding of the operating principles of the machinery, transmission system and its components, and tests of conformity in relation to the possible causes of the transmission system malfunction.</p> <p>Demonstrates comprehensive use of analysis of how the operation of the components could cause the transmission system to malfunction in relation to the operating principles of the components.</p> <p>Demonstrates comprehensive evaluative skills by justifying an excellent range of tests to assess conformity. Justifications are supported with highly detailed and relevant reasoning.</p>
<b>3</b>	<b>7 – 9</b>	<p>Demonstrates thorough application of knowledge and understanding of the operating principles of the machinery, transmission system and its components, and tests of conformity in relation to the possible causes of the transmission system malfunction.</p> <p>Demonstrates thorough use of analysis of how the operation of the components could cause the transmission system to malfunction in relation to the operating principles of the components.</p>

		Demonstrates thorough evaluative skills by justifying a good range of tests to assess conformity. Justifications are supported with mostly detailed and relevant reasoning.
<b>2</b>	<b>4 – 6</b>	<p>Demonstrates good application of knowledge and understanding of the operating principles of the machinery, transmission system and its components, and tests of conformity in relation to the possible causes of the transmission system malfunction.</p> <p>Demonstrates good use of analysis of how the operation of the components could cause the transmission system to malfunction in relation to the operating principles of components.</p> <p>Demonstrates good evaluative skills by justifying a moderate range of tests to assess conformity. Justifications are supported with some detail and relevant reasoning.</p>
<b>1</b>	<b>1 – 3</b>	<p>Demonstrates basic application of knowledge and understanding of the operating principles of the machinery, transmission and its components, and tests of conformity in relation to the possible causes of the transmission system malfunction.</p> <p>Demonstrates basic use of analysis of how the operation of the components could cause the transmission system to malfunction in relation to the operating principles of the components.</p> <p>Demonstrates basic evaluative skills by justifying a limited range of tests to assess conformity. Justifications are supported with minimal detail and relevant reasoning.</p>
	<b>0</b>	<b>No relevant material</b>

<b>Indicative Content</b>	
<b>Analysis</b>	
<b>Components: what can go wrong to cause the transmission to slip when under load and traveling forward:</b>	

Given that the transmission is slipping in only the forward direction, it implies there is an issue with the components linked to this part of the system.

**Electrical/Electronic:**

A fault code may be presented and can be cleared using an Electronic Service Tool (EST)/Electronic Diagnostic Tool (EDT) or by following a set procedure with the on-board computer. Once the error code is removed, the tractor should be tested to see if it reappears. A calibration should also be carried out to make sure all components are using the correct settings and to ensure any historical wear is accounted for.

Wiring and connections to pulse width modulated (PWM) valve which controls oil flow to forward clutch pack. There could be high resistance due to broken wires or corroded/loose connection.

Faulty Signal from transmission controller to PWM valve.

**Hydraulic:**

Visual inspection of oil and level to ensure the correct quantity of oil is available.

Internal leak from valve block or lines/connections to clutch pack causing a loss of pressure.

PWM valve controls oil flow to clutch pack and if it is not fully opening or closing, this could cause a drop-in pressure within the clutch feed circuit which causes slip.

Oil shear could occur if temperature of oil is increased significantly.

**Clutch pack:**

Seals designed to prevent oil leaking out of clutch pack and allow pressure to build up behind the piston and inside clutch drum to create clamping force of clutch.

Piston forces the Belville spring to push the clutch plates and separator plates against the thrust plate to transmit drive. If warped, this could cause slipping.

Clutch plates have an abrasive facing to increase friction and transmit drive to separator plates. They are normally splined to the output hub/shaft of the clutch. If worn, they will allow slippage to occur and the piston to travel too far which may reduce oil pressure.

Separator plates are like clutch plates but have no abrasive facing – they allow friction to be created with the abrasive face of the clutch plates. They are normally splined to the input drum/basket of the

clutch via lugs. When worn, their thickness reduces and clamping pressure will be reduced leading to clutch slip.

**Mechanical:**

Gears transmit the rotational force to other gears or shafts. If teeth and/or splines are worn then slippage may occur.

Shafts transmit rotational force to/from gears/clutches. They usually have splines that link them to these devices and these can wear leading to slippage.

**Justifications**

**Tests of conformity to identify component(s) that could cause the transmission to slip:**

The signals to and from the electronic controller can be monitored using an Electronic Service Tool (EST)/Electronic Diagnostic Tool (EDT) or scanning tool. This tool can pick up fault codes and allows the technician to monitor signals from various sensors and actuators. This can save time as the technician can be directed to the area where a fault may be occurring. The EST/EDT can be used to clear fault codes, update software and allow for a calibration to be carried out. This process is vital as, in many cases, updated software or calibration can rectify issues within the transmission system without the need for further work being completed.

A digital multi-meter can be used to measure voltage being applied to the PWM valve to ensure that the correct signal is being received. This is a basic test with limited scope, however it can be used to identify a poor/weak signal. An oscilloscope could be used to measure this signal too, as it gives a more accurate picture to the signal being received and can pick up issues that a multi-meter cannot. The digital multi-meter could be used to measure resistance of the cables and connections to ensure that the signal was not being compromised due to bad connections or corrosion.

Fitting an appropriately scaled and calibrated pressure gauge to test the port for the forward clutch to ensure oil pressure is within manufacturers' specification. This test allows the technician to check if the oil pressure is low, which could indicate an internal leak within clutch pack or worm clutch pack components such as friction/clutch or separator plates.

Visual observation of components when transmission has been stripped to identify worn splines/gears. This visual test is the only test available to check for conformity against manufacturers' specification.

<b>Total Marks</b>	12 marks
<b>AO</b>	AO2 = 4 marks



	AO3a = 4 marks AO3b = 4 marks
<b>Element</b>	5. Land-based equipment and machinery 6. Operating principles of integrated and stand-alone systems and components
<b>Test spec reference</b>	5.1 Types of land-based equipment and machinery. 6.2 Operating principles of gearboxes, transmissions and drivelines, and associated sub-assemblies, components and traction.

**What do we mean by:**

	<b>AO2</b> Application	<b>AO3a</b> Analysis	<b>AO3b</b> Evaluation
<b>Comprehensive</b>	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.
<b>Thorough</b>	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.
<b>Good</b>	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.
<b>Basic</b>	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.

## 7.2. Candidate Responses

### 7.2.1. Band 4

#### Top of band 4 (12 marks)

*A likely cause of the transmission slipping could be a fault in the electro-hydraulic system, particularly the solenoid controlling the forward clutch pack. If the solenoid is receiving a signal from the ECU that is inconsistent, it could cause incomplete/delayed engagement of the clutch, which might lead to slippage. This can be tested by using a diagnostic tool to check for fault codes and monitor the live data from the ECU, so that you can ensure that the correct signal is being sent to the solenoid. Also, inspecting the wiring and connections for signs of damage, corrosion, or high resistance would help you to confirm whether there's an electrical issue affecting solenoid performance.*

*Another strong possibility is a hydraulic issue. The system uses precise hydraulic pressure to engage the forward clutch pack, so any internal leaks or blockages might reduce this pressure, causing slippage under load. If you were to fit a pressure gauge to the hydraulic circuit and test the pressure against the manufacturer's specifications this would allow for identification of any leaks or weak spots within the system. If the pressure drops a large amount, this could point to a leaking seal in the clutch pack or a malfunctioning pressure control valve. Testing the solenoid's operation using a flow meter would help confirm if the correct amount of hydraulic oil is being delivered to the clutch.*

*You should also assess the condition of the transmission oil, as degraded oil can reduce the efficiency of the system. Burnt or discoloured oil might indicate excessive friction within the clutch pack, while the presence of metallic particles in the oil would suggest that the clutch plates or other components are worn. A complete oil change, then closely monitoring how quickly the oil degrades again, would help determine if there are underlying issues like worn clutch plates or separator plates that need to be addressed.*

*The clutch pack itself is a critical component so any wear on the clutch plates or separator plates can reduce the friction needed to engage the transmission properly. Worn plates will result in the clutch slipping under load. Disassembling the clutch pack and inspecting the plates for wear particularly thinning or warping would confirm whether the clutch pack is the root cause. If the plates are worn they must be replaced to restore proper transmission function.*

*An ECU calibration should be performed to ensure that all settings are correct, including those controlling the clutch engagement timing. This can be done using the onboard diagnostics or an electronic service tool which will reset the ECU to the manufacturer's original specifications, potentially resolving the slippage issue if it was caused by a miscalibration.*

## **Examiner Commentary on application of mark scheme**

This response demonstrates a comprehensive understanding of both the electro-hydraulic and mechanical aspects of the transmission system.

The candidate skilfully applies a wide range of knowledge, accurately identifying the likely causes of the malfunction and justifying multiple, well-chosen tests. The detailed analysis of potential issues, such as electrical faults, hydraulic leaks, and clutch wear, is thorough, and the use of diagnostic tools, pressure gauges, and flow meters is clearly explained. The reasoning for each test is substantiated, and the candidate makes excellent use of calibration and component inspection to reinforce their conclusions.

This is a highly relevant and well-rounded answer with excellent evaluative skills.

### **7.2.2. Band 3**

#### **Top of band 3 (9 marks)**

*One cause for the transmission slipping might be an issue with the electro-hydraulic solenoid that is responsible for engaging the forward clutch pack. The solenoid might not be receiving the correct signal from the ECU, which could lead to improper engagement of the clutch. This can be tested by connecting a diagnostic tool to the ECU to check for any fault codes or irregularities in the signal. Plus the wiring to the solenoid should be inspected for loose or corroded connections, this could prevent the solenoid from functioning correctly.*

*Another cause might be that the hydraulic pressure within the system is too low, which would prevent the clutch from fully engaging. This could be due to an internal leak in the hydraulic lines or a malfunctioning valve. To test this, a pressure gauge could be fitted to the hydraulic system to ensure the pressure is within the manufacturer's specifications. If the pressure is too low, it might indicate a leak or faulty component that needs to be replaced.*

*The oil level and quality within the transmission system should also be checked because low or contaminated oil can cause slippage. If the oil is burnt or contains debris, it could suggest that the clutch plates are worn and need replacing. The forward clutch pack should also be inspected for signs of wear such as thinning clutch plates or worn separator plates, which would reduce the friction needed to engage the transmission properly.*

*Another thing is that it is important to ensure that the ECU is calibrated properly. A miscalibration could cause the transmission to not engage correctly. Recalibration may be necessary after checking the ECU to ensure the settings are correct and functioning according to manufacturer specifications.*

## **Examiner Commentary on application of mark scheme**

The candidate demonstrates a thorough understanding of the potential causes of transmission slippage, with clear application of diagnostic methods. They effectively apply

knowledge of the electro-hydraulic system, identifying specific faults such as solenoid malfunction and hydraulic pressure issues.

The use of relevant testing methods such as diagnostic tools and pressure gauges is well-justified, though explanations could benefit from deeper analysis and evaluation of certain components, such as the forward clutch pack.

Overall, the answer shows a strong ability to link practical tests to the identified faults, with mostly detailed reasoning and supported conclusions.

### **7.2.3. Band 2**

#### **Top of band 2 response (6 marks)**

*One of the first faults to test for is if the electro magnets are pulling the hydraulic valves in correctly which can be tested by measuring the oil flow rate before and after the controller, using a flow rate monitor and then activate the forward gears and see if there is a pressure difference, if there is then replace the forward solenoid.*

*If there is no difference then check the oil for a burnt smell and blackening of the oil as well as any particles in the bottom of the transmission. If there is then disassemble the transmission and replace the wet clutch disk if in the forward part of the transmission.*

*If the oil is clean then check that the operation of the tractor is not exceeding the rated power of the tractor.*

*If nothing is wrong with the power output then check that the oil clutches are not leaking internally by using a manually operated pump to supply pressure to the clutch and record how fast the pressure leaks, if the pressure is constant the seals are ok but if the pressure leaks away then the seals are bad and the clutch needs to be rebuilt.*

*If there is no fault found then check that the ground speed sensor is correctly working as it might disengage drive when pulling a load. If faulty replace and check again.*

#### **Examiner Commentary on application of mark scheme**

The candidate demonstrates a good understanding of diagnosing transmission issues and identifies relevant tests, such as measuring oil flow and checking for contamination. However, the application of knowledge lacks depth, particularly in explaining how specific components, like solenoids and clutches, contribute to transmission slippage.

The analysis touches on relevant factors but does not fully explore how variations in flow or pressure impact the system. Evaluation is present but lacks detailed justifications, particularly for testing the ground speed sensor and power output.

To move into a higher band, the candidate would need to provide more detailed explanations and stronger justifications for their diagnostic approach.

## 7.2.4. Band 1

### Top of band 1 response (3 marks)

*One reason why it could be malfunctioning could be the ECU could be faulty and is putting out wrong signals. This could be tested by plugging in a diagnostic laptop/tool to check the ECU. Another reason could be a loose or faulty connection within the electronic system, which could cause it to not send a signal at all. This could be tested with a diagnostic tool to see if different sensors or components are energised.*

*Another reason could be there is low oil which operates the clutch causing an incorrect engagement. This could be tested by checking the clutch hydraulic oil tank to see if it is at the correct level. Another reason could be that there is not enough oil pressure within the system or there is too much pressure causing it to stick on and causing slippage. This could be tested by possibly fitting a pressure gauge to test if it is running at the correct pressure.*

*Another reason could be the oil within the transmission is being sent to the back due to the movement forward causing it to slip. You could test this by seeing it happens in reverse and if not then possibly there is not enough oil or any buffers within the gear box are not stopping the oil from moving.*

*Another reason could be that the clutch has gone and that it is slipping because it is grabbing so often causing it to slip. This could be tested by checking the clutch yourself and comparing it to the manual.*

*Another reason could be the gearbox oil level is low. This could be tested by checking the level and comparing it to the fill marks.*

### Examiner Commentary on application of mark scheme

The candidate identifies basic potential causes for the transmission malfunction, such as a faulty ECU, low oil, or clutch issues, and suggests relevant diagnostic tests like using a diagnostic tool and checking oil levels. These suggestions demonstrate a basic understanding of appropriate testing methods.

However, the explanations lack detail on how these issues specifically impact the transmission system, and the analysis of faults is underdeveloped. While the candidate suggests tests, there are limited justifications provided for why these tests would confirm the fault, reducing the evaluative strength of the response.

To improve, the candidate would need to provide more detailed explanations of the issues and stronger reasoning behind the diagnostic tests, but the inclusion of relevant tests shows an initial grasp of the problem-solving process.

### 7.3. 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 don't spend too much time 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 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 i.e. making multiple points, against ensuring they demonstrate their depth of understanding on the subject matter. If candidates recall 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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