Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2022

Marking Scheme

Agricultural Science

Note to teachers and students on the use of published marking schemes

Marking schemes published by the State Examinations Commission are not intended to be standalone documents. They are an essential resource for examiners who receive training in the correct interpretation and application of the scheme. This training involves, among other things, marking samples of student work and discussing the marks awarded, so as to clarify the correct application of the scheme. The work of examiners is subsequently monitored by Advising Examiners to ensure consistent and accurate application of the marking scheme. This process is overseen by the Chief Examiner, usually assisted by a Chief Advising Examiner. The Chief Examiner is the final authority regarding whether or not the marking scheme has been correctly applied to any piece of candidate work.

Marking schemes are working documents. While a draft marking scheme is prepared in advance of the examination, the scheme is not finalised until examiners have applied it to candidates' work and the feedback from all examiners has been collated and considered in light of the full range of responses of candidates, the overall level of difficulty of the examination and the need to maintain consistency in standards from year to year. This published document contains the finalised scheme, as it was applied to all candidates' work.

In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with their Advising Examiners when in doubt.

Future Marking Schemes

Assumptions about future marking schemes on the basis of past schemes should be avoided. While the underlying assessment principles remain the same, the details of the marking of a particular type of question may change in the context of the contribution of that question to the overall examination in a given year. The Chief Examiner in any given year has the responsibility to determine how best to ensure the fair and accurate assessment of candidates' work and to ensure consistency in the standard of the assessment from year to year. Accordingly, aspects of the structure, detail and application of the marking scheme for a particular examination are subject to change from one year to the next without notice.

How to use the marking scheme

- Examiners must conform to this scheme, however the descriptions, methods and definitions given in the marking scheme are not exhaustive and alternative valid answers are acceptable.
    - This does not preclude synonyms or terms or phrases which convey the same meaning as the answer in the marking scheme. Although synonyms are generally acceptable, there may be instances where the scheme demands an exact scientific term or unequivocal response and will not accept alternatives.
- The marking scheme is a concise and summarised guide to awarding marks and is constructed in order to minimise its word content.
    - In many cases only key phrases are given in the marking scheme. These points contain the information and ideas that must appear in a candidate's answer in order to merit the assigned marks.
- If an examiner determines that a candidate has presented a valid answer, and where there is no provision in the scheme for accepting that answer, then the examiner must first consult with his/ her advising examiner before awarding marks.
- The detail required in any answer is determined by the context, the phrasing of the question, and by the number of marks assigned to the answer in the examination paper. This may vary from year to year.
- Where only one answer is required alternative answers are separated by '**or**'.
- Use of an **asterisk*****
    - This happens when the only acceptable answer is a specific word or term. Each such instance is indicated in the scheme by an asterisk*.
- Use of a **solidus** (**/**)
    - Words, expressions or statements separated by a solidus (**/**) are alternatives that are equally acceptable for a particular point.
    - Where multiple answers are required each word, term or phrase for which marks are allocated is separated by a solidus (**/**) from the next word, term or phrase.
- Use of **brackets ( )**
    - A word or term that appears in brackets **( )** in the scheme is not a requirement of the answer, but is used to contextualise the answer or may be an alternative valid answer.
- **Note** however, that words, expressions or phrases must be correctly used in context and not contradicted and where there is evidence of incorrect use or contradiction, the marks may not be awarded.
- The mark awarded for an answer appears in **bold** in the mark's column, e.g. **2**.
- Where there are several parts in the answer to a question, the mark awarded for each part appears as e.g. **3(2)**. This means there are 3 parts to the answer, each part is allocated 2 marks.
- Award unit marks separately e.g. if an answer merits three 2-mark units, write 3 separate '2's, under each other, in the space at the right-hand side of the question in the answer book (**2, 2, 2**).
- The answers to subsections of a question may not necessarily be tied to a specific mark e.g. there may be four parts to a question - (i), (ii), (iii), (iv) and a total of 10 marks

allocated to the question. The marking scheme might be as follows: 4 + 2 + 2 +2. This means that the first correct answer encountered is awarded 4 marks and each subsequent correct answer is awarded 2 marks.

- Italics are used where the examiner's attention is being drawn to an instruction relating to the answer or to some qualification of the answer.
- In general, names and symbols / formulae of elements / compounds are equally acceptable. However, in some cases where a name is specifically asked for, the symbol / formula may be accepted as an alternative. This will be clarified within the scheme.
- Examiners should write the total mark for each question at the beginning of the question, beside the question number, and circled.
- The cumulative total should be written in the bottom right-hand corner of each page on which a question total appears.
- All blank pages should be marked to indicate they have been inspected.

Cancelled answers

- The following is an extract from S.63O *Instructions to Examiners, 2022* (section 5.4, p.19), *"Where a candidate answers a question or part of a question once only and then cancels the answer, you should ignore the cancelling and treat the answer as if the candidate had not cancelled it.*"
- If the only answer offered is cancelled ignore the cancelling and mark as usual.
- If an answer is cancelled and a second version of the answer is given, you should accept the cancellation and award marks, where merited, for the un-cancelled version only.
- If two un-cancelled versions of an answer are given to the same question or part of a question, mark both and accept the answer that yields the greater number of marks. You may not, however, combine points from both versions to arrive at a manufactured total.

Surplus answers

- A surplus wrong answer cancels the marks awarded for a correct answer.
    - e.g. Question: Identify the cattle and sheep breeds.
      Marking scheme: A = Suffolk / B = Shorthorn / C = Belgian blue / D =Texel - **4(1)**
      Candidates Answer = A = Texel, Suffolk / B = Shorthorn / C = Belgian blue / D =Texel
      The surplus answer (Texel) is incorrect,
      Therefore, the candidate scores 4 - 1 = 3 marks.

Annotations used in the marking

The scripts were marked on-line by examiners. The following table illustrates the various **annotations** (symbols) applied by the examiners when marking the scripts. The meaning and use of each of the annotations applied are explained in the table below. These annotations will be seen on a script if viewed as part of the appeal process. In some sections of the 'Individual Investigative Study' (IIS), where the mark award was greater than 12 marks for a single item(s), two annotations will be used to show the total marks awarded for the item(s). Annotations applied by an examiner will be viewed in red. Scripts that were also marked by an advising examiner will show annotations in a green colour.

Annotation	Meaning
✓	This symbol indicates a correct response / answer. Use when all marks awarded to any additional correct answers.
✗	This symbol indicates an incorrect response / answer.
[	This symbol indicates a surplus incorrect answer. A surplus incorrect answer has cancelled a correct answer.
	This symbol is placed on all blank pages or part of page to indicate it has been seen by the examiner.
	This symbol can be used by an examiner to indicate a part of a question answer of significance.
	This symbol is used to indicate where a candidate answer was awarded zero marks.
✓ 1	This symbol can be used by an examiner to indicate **One** mark awarded
✓ 2	This symbol can be used by an examiner to indicate **Two** marks awarded
✓ 3	This symbol can be used by an examiner to indicate **Three** marks awarded
✓ 4	This symbol can be used by an examiner to indicate **Four** marks awarded
✓ 5	This symbol can be used by an examiner to indicate **Five** marks awarded
✓ 6	This symbol can be used by an examiner to indicate **Six** marks awarded
✓ 7	This symbol can be used by an examiner to indicate **Seven** marks awarded
✓ 8	This symbol can be used by an examiner to indicate **Eight** marks awarded
✓ 9	This symbol can be used by an examiner to indicate **Nine** marks awarded
✓ 10	This symbol can be used by an examiner to indicate **Ten** marks awarded
✓ 11	This symbol can be used by an examiner to indicate **Eleven** marks awarded
✓ 12	This symbol can be used by an examiner to indicate **Twelve** marks awarded

Marking the Individual investigative Study (IIS)

Read the entire Individual Investigative Study (IIS) without allocating any marks. Mark the IIS using the marking criteria and total the marks. Each section of the IIS is awarded a single mark, which varies between sections (e.g. Introduction and back ground research is awarded 20 marks). To assist in the awarding of marks 'indicative content' has been stated for each section; e.g. in considering the allocation of marks for the introduction and background research section, this can be considered under;

- Introduction (context for the IIS) and
- Background Research (research, sources and knowledge).

To finalise the marks, review the criteria descriptors against the marked work.

Ordinary Level Agricultural Science Marking Criteria for Individual Investigative Study

Before commencing marking read the entire Individual Investigative Study to familiarise yourself with the content presented for marking.

Note: Be careful not to penalise skilful brevity, nor to reward unwarranted length.

These descriptors should be interpreted in the context of the challenges and demands of the investigation the candidate has chosen.

Section	Very Good	Good	Fair	Weak
Introduction and background research Suggested range between 300 and 500 words	Study reasonably addresses the brief theme in a context, even if the context is limited. Adequate level of knowledge with understanding; does not need to be fully coherent throughout. Identifies and interrogates a limited range of relevant and credible sources of evidence to support study. No significant omissions / errors.	Brief theme is addressed at a basic level with the context not well developed. Basic knowledge and limited understanding of the theme. Lacks depth and structure. Identifies and presents a narrow range of evidence simply with an overreliance on unsubstantiated data. Contains minor omissions / errors.	Brief theme is vaguely addressed and understood with no context developed. Knowledge and understanding of theme is poor. Very simplistic structure. Evidence presented is limited, simplistic or confused and only vaguely relevant to the theme. Contains major omissions / errors.	Brief theme is completely misunderstood. Little or no understanding and knowledge of the theme. Little or no evidence presented, with presented evidence not relevant to the theme. Information may be incorrect or contradictory. Contains significant omissions / errors.
20 marks	**16-20**	**12-15**	**8-11**	**0-7**

Award a single mark out of 20 for this section. In arriving at this mark consider the indicative content requirements below.

Introduction - context for the IIS - 10 marks	• Very Good - 8 - 10 marks • Good - 6 - 7 marks • Fair - 4 - 5 marks • Weak - 0 - 3 marks	*Background research - research, sources and knowledge - 10 marks*	• Very Good - 8 - 10 marks • Good - 6 - 7 marks • Fair - 4 - 5 marks • Weak - 0 - 3 marks

Section	Very Good	Good	Fair	Weak
The investigative process Suggested range between 500 and 800 words	Identifies and provides a description of the investigative process undertaken, which may have some limitations. A valid hypothesis was generated and tested. Ideas, concepts and theories make tentative links between at least some aspects of the task. At least one experiment involving gathering and processing data. A logical description of how data was gathered, which may have some omissions / errors. An attempt at linking to learning outcomes of specification.	Identifies and provides a simplistic description of the investigative process undertaken. A simplistic hypothesis was generated and tested. At least one experiment involving gathering and processing data. Description of how data was gathered is vague, with some omissions / errors. Vague linking to learning outcomes of specification.	Simplistic or confused details of the investigative process presented and only vaguely relevant to the theme. Very simplistic hypothesis generated and tested. At least one experiment involving gathering and processing data with only a very poor description of how data was gathered with major omissions / errors. Very poor linking to learning outcomes of specification.	Little or no details of the investigative process presented and which has no relevance to the theme. A very poor hypothesis or no hypothesis generated. At least one experiment involving gathering and processing data with very poor description of how data was gathered which is also incorrect and /or contradictory. No link with learning outcomes of specification.
25 marks	**20-25**	**15-19**	**10-14**	**0-9**

Award a single mark out of 25 for this section. In arriving at this mark consider the indicative content requirements below.

Details of the actions undertaken in response to stated hypothesis – 12 marks	• Very Good - 10 - 12 marks • Good - 8 - 9 marks • Fair - 5 - 7 marks • Weak - 0 - 4 marks	*Data collection undertaken - 13 marks*	• Very Good - 11 - 13 marks • Good - 8 - 10 marks • Fair - 6 - 7 marks • Weak - 0 - 5 marks

Section	Very Good	Good	Fair	Weak
Results, analysis, and conclusions Suggested range between 600 and 1000 words	Provides an adequate interpretation and evaluation of the data. Presentation is good but may lack some structure. Constructs informed independent conclusion to justify own position (hypothesis), which does not necessarily need to display great depth and structure. Conclusions are based on an analysis of evidence, even if basic in nature.	Limited and basic analysis of the data, with some inaccuracies. Presentation of the data is limited and may have some errors. Some very basic independent conclusion(s) made to justify own position (hypothesis). Conclusions are flawed or made with limited evidence in support. Repetition of material is evident.	Very little interrogation of the data, with many inaccuracies evident. Presentation of the data is very limited and contains many errors. Very limited independent conclusions made to justify own position (hypothesis). Conclusion is flawed with limited evidence of analysis / superficial analysis with significant inaccuracies. Significant repetition of material.	Poor / confused / illogical interrogation of the data. Presentation of data is very poor. Little or no evidence presented / or not relevant, with little or no justification of own position (hypothesis). Analysis is poor or not present. Conclusions are not present or significantly flawed. Significant amounts of and presentation and irrelevant material evident.
35 marks	**28-35**	**21-27**	**14-20**	**0-13**

Award a single mark out of 35 for this section. In arriving at this mark consider the indicative content requirements below.

Appropriate presentation of data - 10 marks	*Informed judgement and conclusions following analysis - 15 marks*	*Limitations of study considered and clear linkage of conclusions to research question – 10 Marks*
• Very Good - 8 - 10 marks • Good - 6 - 7 marks • Fair - 4 - 5 marks • Weak - 0 - 3 marks	• Very Good - 12 - 15 marks • Good - 9 - 11 marks • Fair - 6 - 8 marks • Weak - 0 - 5 marks	• Very Good - 8 - 10 marks • Good - 6 - 7 marks • Fair - 4 - 5 marks • Weak - 0 - 3 marks

Section	Very Good	Good	Fair	Weak
Reflection on the study Suggested range between 150 and 200 words	A personal reflection on the completed work is evident. Considers some elements of the learning gained through engagement with the study. Considers some aspects of reliability, possible error(s), changes / modifications while relating it back in some way to the theme and hypothesis.	A personal reflection base on some insights gained through completion of the work is attempted. Considers at a basic level the learning gained through engagement with the study. Considers very simply reliability, possible error(s), changes / modifications with some attempt to link back to the theme and hypothesis.	A limited personal reflection on the completed work. Poor reference to the learning gained. Poor consideration of reliability and possible error(s) and any possible changes / modification, with very limited link back to the theme and hypothesis.	Weak / no personal reflection on the completed work. Little or no reference to the learning gained. Little or no consideration of reliability and possible error(s) and any possible changes / modification very limited or absent. Very weak linkage to the theme and hypothesis.
10 marks	**8-10**	**6-7**	**4-5**	**0-3**
Award a single mark out of 10 for this section. In arriving at this mark consider the indicative content requirements below.				
The candidate presents coherent reflections, lessons learned and significance of the study - 10 marks	• Very Good - 8 - 10 marks • Good - 6 - 7 marks • Fair - 4 - 5 marks • Weak - 0 - 3 marks			
References	References for the all or almost all of sources used during the study and / or referred to in the report.	References for most sources used during the study and / or referred to in the report.	References missing for a significant number of sources used during the study and / or referred to in the report.	Lack of referencing and references for sources used during the study and / or referred to in the report.
-	-	-	-	-
References should be checked within section(s) and linked to this section of study. *Any issues with the referencing should effect the mark awarded to the section in which the references are being cited in the study.*				

Section	Very Good	Good	Fair	Weak
Communication and innovation (This is not a distinct section of the report)	The study has a reasonable coherence in its structure and adheres to the IIS structure. Work is focused with material labelled appropriately and organised. Communication of data and information is clear but simplistic. Some evidence of innovative thinking and an individual approach.	In the main, the study adheres to the IIS structure. The work may lack focus in parts and there may be some omissions in both content and errors in labelling of material. Study organisation and coherence is of a basic level with limited evidence of originality and innovative thinking.	Poor construction and structure, with only some adherence to the IIS structure. Organisation and coherence is limited and confused throughout with many errors. Little evidence of originality and innovative thinking.	The work lacks structure, organisation, coherence, focus, context and clarity. IIS structure not well used. Irrelevant material and significant errors. No evidence of originality and innovative thinking.
10 marks	**8-10**	**6-7**	**4-5**	**0-3**
Award a single mark out of 10 for this section. In arriving at this mark consider the indicative content requirement below				
The report has an overall coherence, quality and clarity with the inclusion of individual innovative thinking by the candidate - 10 marks	• Very Good - 8 - 10 marks • Good - 6 - 7 marks • Fair - 4 - 5 marks • Weak - 0 - 3 marks			

Section A		Answer any 7 questions 10 marks for each question Total for section is 70 marks	Marks
Q1	**(a)**	*Identify and state the function of machine A and B* ***A*** = (fertiliser) spreader *Function* = spread (shake or broadcast) fertiliser / spreading grass seed ***B*** = Slurry spreader or slurry tanker or trailing shoe or injector *Function* = spreading slurry or effluent	**2** **2** **2** **2**
	(b)	*State **one** safety precaution when working with machine B* Don't wear loose clothing around the PTO / ensure the PTO is (properly) covered / tanker is serviced regularly / be careful not to inhale fumes from slurry or keep windows of the tractor closed / used by trained operator or drive safely / avoid manholes / make sure area clear of people	**2**
Q2	**(a)(i)**	*Identify **any three** of the breeds* ***A*** = Simmental ***B*** = Landrace ***C*** = Blackface mountain or Swaledale ***D*** = Jersey	**3(2)**
	(ii)	*Describe **two** traits which make animal A suitable for selection as a sire* Good conformation or well-muscled / dual purpose breed (good beef and milk qualities) / good liveweight gain (LWG) or food conversion ratio (FCR) / good temperament / heavy carcase or high % kill out / lean carcase / early maturing / short calving interval	**3+1**
Or			
	(b)(i)	*Identify breed E and F* **E** = Border Leister **F** = Texel or Beltex	**3+1**
	(ii)	*Suggest with reason which breed E or F Jessica would choose to cross with her Suffolk X ewes for replacements in the flock* **E** = good milk production / prolific / easy lambing / good mothers / hardy or good survival rate / good growth rate / calm or easy to handle / maternal sire **F** = hardy or good survival rate / prolific / good mothers / good growth rate / excellent conformation	**3+1**
	(iii)	*Outline **one** reason why Jessica choose to have Suffolk X ewes rather than purebred ewes* Hybrid vigour – when cross two different breeds you get the best traits from both breeds / cross bred ewes are hardier than purebred or are easier to manage / crossbred ewes are less susceptible to diseases / crossbred ewes produce heavier or superior quality lambs (at weaning) or excellent conformation or good carcase quality or fast growth rates / crossbred ewes have a higher lambing percentage / lambs are early maturing	**2**

Q3	**(a)**	*Briefly describe how to carry out an investigation to determine the pH of a soil sample in the school laboratory* Add soil sample to beaker and add distilled or deionised water / stir or mix well / add filter paper to funnel (in retort stand) / pour the mixture into the funnel / collect the filtrate (filtered soil solution) / add pH paper or universal / note colour change / compare colour to colour chart (to determine the pH) **Or** Add soil sample to beaker and add distilled or deionised water / stir or mix well / turn on pH meter and calibrate using buffer solutions / clean probe by inserting into distilled water (pH 7) / ensure pH reading correctly – pH 7 / place probe into (stirred) solution / record reading / clean probe into distilled or deionised water after reading	**3(2)**
	(b)	*Suggest **one** implication for growing crops and **one** way the student could alter the pH of the soil* *Implication:* low nutrient availability or nutrient deficiencies in the crop / reduced crop yield / decreased growth rate of crop / affect earthworm activity *Alter pH:* adding lime to the land	**3+1**
Q4	**(a)(i)**	*Explain biodiversity* Variety of plant and animal life in a habitat (ecosystem)	**4**
	(ii)	*Describe **two** requirements a farmer would have to achieve in order to farm organically* No chemical fertiliser used or only use slurry or FYM (organic fertilisers) (as sources of nutrients for the land) / pesticides or herbicides are not permitted or use biological controls to control pests or hand rogueing or stubble cleaning or crop rotation or break crops or increase seed rate to control weeds / no antibiotics or animal doses used (unless prescribed by a vet) or prevent any chemicals entering the food chain / all feed must be purchased from a certified organic source or can't be grown using chemical fertilisers / reduce stocking density (rate) or allow animals more space to graze / increase space for each animal during housing or must have organic straw bedding (50%) to lie down during housing or better animal welfare / permanent housing of all stock is not allowed or animals must be allowed outside / stock must only be purchased from organic producers or animals must undergo conversion period / sow clover or aid in N levels	**2(2)**
	(iii)	*State **one** advantage of farming organically* Minimises the external cost of farming / efficient use of resources / good soil health or land free from chemicals / better for environment (as less leaching of nutrients or pollution) / healthier or higher quality food (as less chance of chemical residue) / healthier animals (reared in better condition or free range) / higher price for produce (niche market) / increased biodiversity (less chemicals used) /crops are not genetically modified	**2**

		Or	
	(b) **(i)** **(ii)** **(iii)** **(iv)** **(v)**	*Indicate if the following statements are true or false* False True True False False	**5(2)**
Q5	**(a)**	*Explain the terms maintenance and production diets* *Maintenance diet* – amount of feed given to an animal to maintain good health or condition or with no loss or gain in weight *Production diet* – extra amount of feed required and used for production of some kind (1kg of LWG or 1 litre of milk or 1 kg of wool or produce calf or lamb)	**1** **1**
	(b)	*State the function of protein and fibre in the diet of a beef animal* *Protein:* growth or repair / milk production / provide ammonia for microbial growth / provide amino acids necessary for absorption from small intestine / used in production of energy *Fibre:* stimulates rumination or chewing the cud or saliva production / helps maintain rumen pH (7) or keeps rumen functioning / reduces occurrence of acidosis / maintain optimum microbial levels of good bacteria / prevent constipation	**2(4)**
Q6	**(a)**	*Explain selective herbicide* (Herbicide that) controls specific (target) weeds or weed categories / a chemical which is toxic to some plant species or less toxic to others / chemical that will kill or target certain plants and not others	**2**
	(b)	*Identify safety symbols A and B* ***A*** = Health hazard / carcinogenic ***B*** = Harmful / caution / danger / warning / irritant	**2** **2**
	(c)	*State **two** precautions farmers should take when applying herbicides* Wear protective gloves (PPE) / wear goggles / wear overalls / wear mask / keep windows or doors of tractor closed / do not eat or drink or smoke / if you come into contact with spray, wash off immediately / do not spray in windy conditions or near animals or near waterways / apply at correct concentrations	**2(2)**

Q7	**(a)(i)**	*Identify **one** feature of the root which allows it to absorb nutrients* Root hairs / thin outer wall / long length	**3**
	(ii)	*List **one** nutrient absorbed through the root which is required for healthy plant growth* Nitrogen (N) / phosphorus (P) / potassium (K) / sulphur (S) / calcium (Ca) / magnesium (Mg) / trace element	**3**
	(iii)	*A farmer discovers his crop is deficient in the nutrient named in (ii) above. Describe (1) a symptom and (2) the treatment for this deficiency*	**Symptom - 2** **Treatment - 2**

Nutrient	***1. Symptoms***	***2. Treatment***
Nitrogen	Spindly yellow plants or yellow leaves / leaves may have pink tints / stunted growth/ necrosis (death) of older leaves	Spread chemical nitrogen (Urea or protected urea or CAN or named chemical compound e.g. 18-6-12) / spread slurry / spread FYM
Phosphorus	Reduced shoot growth / leaves turn dark or dull or blue-green or pale in severe deficiency / reddish or reddish-violet, or violet colour develops / lack of fruit or flowers/ wilting / delayed maturity	Spread chemical phosphorus (named chemical compound e.g. 10-10-20 / spread FYM / spread slurry)
Potassium	Chlorosis (yellowing) at the leaf margins / reduced yield or slow growth / scorching of leaves / poorly developed root system / weak stalks	Spread chemical potassium (potash) (named chemical compound e.g. 10-10-20 / spread FYM / spread slurry
Sulphur	Plants are small and spindly / with short and slender stalks / stunted growth (prevent plants from utilising nitrogen) / maturity in cereals is delayed / nodulation in legumes may be poor or nitrogen-fixation reduced / fruits often do not mature fully and remain light-green in colour / chlorosis of leaves	Spread chemical sulphur (with fertiliser) / spreading slurry / spreading FYM
Calcium	Symptoms first appear on younger leaves and tissues / growth is inhibited / plants have a bushy appearance / youngest leaves are usually small or misshapen / brown chlorotic spots developing along the margins which spread to eventually unite in the centre of the leaves	Adding lime (to soil in autumn) / apply a calcium supplement
Magnesium	Chlorosis (yellowing of the leaves) or interveinal chlorosis (yellowing of the leaf with the veins remaining green) / reduced growth	Adding lime / apply a magnesium supplement

Or			
	(b)(i)	*Identify **A**, **B** and **C** in picture illustrating photosynthesis* ***A*** = Carbon dioxide (CO_2) ***B*** = Oxygen (O_2) or water vapour ***C*** = Glucose ($C_6H_{12}O_6$) or oxygen or water vapour	**4+1+1**
	(ii)	*Describe **two** ways a leaf is adapted to carry out photosynthesis* Flat (large surface area for max absorption of light) / thin (for diffusion of gases) / waxy cuticle (prevent water loss) / palisade layer (tightly packed together with large number of chloroplasts for max light absorption) / spongy mesophyll (many air spaces for rapid diffusion of gases) / vascular tissue (xylem or phloem) - (transport of water or removal of sugars for storage) / stomata (gas exchange) / guard cells (open and close stomata)	**3+1**
Q8	**(a)**	*Identify **A** and **B*** ***A*** = Inoculating loop ***B*** = Petri dish or agar plate	**2** **2**
	(b)	*State a suitable predication for this investigation* (I predict that (white) colonies of) bacteria will grow on the agar plate (streaked with bacteria from root nodules and no growth on control plate)	**1**
	(c)	*State a reason why students were advised to wash the clover roots in disinfectant before carrying out the investigation* To kill any micro-organisms on the outside of the roots	**2**
	(d)	*Identify the bacteria in root nodules of clover that are responsible for fixing nitrogen* Rhizobium	**3**
Q9	**(a)**	*Identify which year farmers achieved the highest price per kg for their sheep meat and give one reason for your answer* *Year* = 2021* *Reason:* Global sheep prices were high / coronavirus caused tight supplies / increased demand or tight supply / lower production levels in the UK / lower imports from New Zealand / increases in shipping or fuel costs or feed costs	**3** **1**
	(b)	*State which year farmers achieved the lowest price per kg for their sheep meat* 2013*	**2**
	(c)	*Identify the average slaughter weight of lambs* 42*(kg)	**3**
	(d)	*State the ideal fat class required for lambs at slaughter* 3 or 3L	**1**

<table>
<tr><td>Q10</td><td>(a)</td><td>Describe two tests a farmer could do to assess the quality of the silage at the pit face
<table>
<tr><th>Test</th><th>Description</th></tr>
<tr><td>pH</td><td>Good quality – squeeze silage juice into a jar and place pH probe in or pH paper – pH 4
Poor quality - squeeze silage juice into a jar and place pH probe in or pH paper – pH >5</td></tr>
<tr><td>Texture</td><td>Good quality – firm and fibres do not wear easily
Poor quality – soft or wet or slimy</td></tr>
<tr><td>Colour</td><td>Good quality – green or yellow in colour
Poor quality – darker or brown colour</td></tr>
<tr><td>Smell</td><td>Good quality - sweet perfume or sharp vinegary smell (which indicates excellent preservation)
Poor quality - putrid or rancid smell</td></tr>
<tr><td>DMD</td><td>Good quality - separate the leaves from the stems / if you roughly calculate the leaf-to-stem ratio to be 70:30, then you could say that the silage has a DMD of roughly 70-72% or a satisfactory DMD
Poor quality - separate the leaves from the stems / if the ratio of leaf-to-stem is 60:40, then DMD of silage is roughly 60-62% or unsatisfactory</td></tr>
<tr><td>DM</td><td>Good quality - squeeze the silage and note any moisture. Very little or no water released indicates high DM
Poor quality – squeeze the silage and note any moisture. Water released indicates low DM.</td></tr>
</table></td><td>2+1</td></tr>
<tr><td></td><td>(b)</td><td>Calculate the DM% of the silage
20÷85 X 100÷1
= 23.5% or 24%
(If a candidate gives 23.5% or 24% without showing any calculation they may be awarded 4m)</td><td>2
2</td></tr>
<tr><td></td><td>(c)</td><td>State two precautions student should take when obtaining silage samples from pit face to ensure accuracy when sampling
Samples taken at random or 10 - 12 samples or in a W shape / samples not taken near the edges of the pit or from the open face of the pit / samples should not be taken if spoiled / use corer to take the sample or dig through about 20cm from pit face / mix all samples in bucket / put in zip lock bag and remove as much air as possible / sampling bales from same batch (min 5) / safety - be aware of silage falling from overhead at the pit face or any one valid safety point</td><td>2+1</td></tr>
</table>

Q11	**(a) (i)**	*State the cause of this disease* Roundworm or lungworm or nematode	**1**
	(ii)	*State **one** way this disease can be treated* Dose or inject cattle (with anthelmintics)	**3**
	(iii)	*Briefly explain **one** way to prevent this disease* Rotational grazing or leader follower grazing or good grazing management / vaccinate young calves	**2**
	(iv)	*Outline **one** reason young calves are more susceptible to hoose that older animals* (Calves have) less immunity or older animals have higher immunity	**3**
	(v)	*Explain economically important disease* Disease that impacts livestock production through direct costs (deaths or morbidity or reduction in productivity) / impacts livestock production through indirect costs (prevention and control measures)	**1**
Or			
	(b)(i)	*State if the breed is a continental or British breed* Continental breed	**3**
	(ii)	*Explain conformation* Shape or muscle (distribution) of animal	**2**
	(iii)	*Calculate the ADG of heifer from March to September* 788 – 533 = 255kg 255 ÷ 185 = 1.378 or 1.38 or 1.4kg (If the candidate gives 1.378 or 1.38 or 1.4kg without showing any calculations they may be awarded 4m)	**2** **2**
	(iv)	*Suggest **one** advantage of compensatory growth* Increased LWG (ADG) / improved feed efficiency / decreased feed costs / better carcass scores or higher market prices	**1**

Q12 **(a)** *Describe how any **three** factors are involved in soil formation*

Factor	Description
Parent material	Soil is formed by weathering of rock / mineral composition / texture or correct example of texture (coarse texture of granitic rocks leads to a coarse loamy soil texture) / pH of the soil is derived from the parent rock
Topography	Erosion will occur in steep slopes / thin layer of soil on hillsides / deep fertile soils in valleys / soils in valleys retain water (easy cultivation)
Time	Over time, vegetation and climate act on parent material and topography / development determines a soil's age / the degree of aging depends on the intensity of the other four soil-forming factors
Climate	Temperature – heat and cooling of rocks (causing them to break) / low temperature leads to low water evaporation so more water for chemical weathering / precipitation – water contributes to physical or chemical weathering (freezing or solution or hydrolysis or hydration)
Organisms	Provide humus when plant and animals die / microorganisms decompose organic matter (OM contributes to fertility and structure) / roots bind soil together / grasses contain alkaline compounds which reduce acidity in soil / acidic soils developed under forests / earthworms improve drainage or aeration or assist in soil formation

2+1+1

(b) *Compare the named soil types under headings by placing the word higher in correct box.*

	Brown Earth	Podzol
Water content		*Higher*
Fertility	Higher	
Humus content	Higher	

2(3)

Section B		Answer any 3 questions 50 marks for each question Total for section is 150 marks	Marks
Q13	**(a)(i)**	*Explain soil texture* Soil texture (such as loam, sandy loam or clay) refers to the proportion of sand, silt and clay sized particles (that make up the mineral fraction of the soil)	**3**
	(ii)	*Calculate A (% clay) for Eileen* 70 + 17 = 87% 100 – 87 = 13% (If a candidate gives 13% without showing any calculations they may be awarded 8m)	**4** **4**
	(iii)	*State **one** error that was made during the investigation* Only collecting one sample / any one valid example *Explain how error could be reduced* Collecting more than one sample / any one valid explanation	**2** **2**
	(iv)	*Explain with the aid of a labelled diagram how to determine the texture of a soil sample using the sedimentation method* Add (sieved) soil sample to beaker of water and stir / pour soil and water into a graduated cylinder / rinse the beaker to ensure all soil is in cylinder / ensure all soil was covered with water / stopper cylinder and shake or invert to ensure soil is mixed thoroughly / leave to settle for a few hours / observe layers in graduated cylinder / using graduation marks to record amount of sand, silt and clay / express the amount of sand, silt and clay as a % of total soil	**3(2)**
	(v)	*Briefly describe which method Eileen or Padraig's (sedimentation or hand testing) is more accurate.* Eileen or sedimentation as it measures accurately the amount of sand, silt and clay in the sample / sedimentation as it gives a quantitative result	**6**
	(vi)	*State which soil type is more suitable to tillage and give two reason for your answer* *Soil type: Padraig's (loam)* *Reasons:* equal amount of sand, silt and clay / fertile soil / good aeration / warmer temperature / good drainage	**6** **4+2**

	(b)(i)	*Sketch onto the photograph the pattern the farmer would use when taking a number of soil samples* W shape on photograph	**4**
	(ii)	*List the piece of equipment the farmer would use to carry out the soil sampling* Soil sampler or corer / soil auger	**4**
	(iii)	*Advise the farmer as to how many soil samples he should take* 20 - 25 samples	**3**
		Or	
	(c)(i)	*Briefly outline **two** reasons why the farmer would carry out a soil analysis on his farm* Optimise plant health / create accurate fertiliser or nutrient management plan / reduce excess fertiliser or cost or less chance of leaching / apply nutrients when required or determine the nutrient content of soil / determine soil pH for crop suitability/ increased crop yields	**2(2)**
	(ii)	*State **one** area in a field the farmer should avoid when soil sampling and give a reason for your answer* *Area:* Gateways / pathways / water troughs / feeding troughs / headland / near hedgerows / marshland or wet land or sloped areas *Reason:* High amount of traffic (animals) or poaching in these areas or not a representative sample of the field	**4** **3**
Q14	**(a)**	*Outline **two** reasons for good ventilation in sheds* Reduce chance of an animal getting pneumonia or chills or (air borne) disease or clean (fresh) air for breathing / improving the performance of animal / better animal welfare / less use of antibiotics / prevent build-up of damp / temperature regulation / allow for safe slurry agitation	**5+2**
	(b)(i)	*Outline **two** advantages of housing sheep before lambing* Allow pasture to recover / allow for early bite in spring / easier management of ewes during lambing (feeding or supervision or observation) / lower mortality in lambs (due to hypothermia or chills) / easier management of lamb (colostrum, tagging etc.) / easier to foster lambs / less predation or safer	**5+2**
	(ii)	*Outline **two** advantages of incorporating headlock barriers into the design of sheep and cattle sheds* Easier to handle animals or animals don't escape / no need to move animals to crush / safer for farmer when bedding / decreased bullying of animals at feeding (especially concentrates) or control of animals at feeding	**5+2**

<table>
<tr><td></td><td>(c)(i)</td><td>Describe how they would house the ewes to ensure best management practices
House ewes carrying same number of lambs together / house ewes carrying singles and triplets (closer to each other for ease of fostering) or separate ewes with different lambing dates / one individual pen for every 6 ewes / house the ewes on a dry day (fleece not wet) / ensure adequate feed space for ewes (400mm – 600mm space per ewe) / central feed passage / ensure adequate floor space for ewes (1.2 m²) / adequate pen depth (2.7 m) / hay bedding or slats / adequate supply of fresh water</td><td>4+4</td></tr>
<tr><td></td><td>(ii)</td><td>Describe the feeding requirements of the pregnant ewe during flushing and steaming up
Flushing: ewes are put on a (low plane of nutrition or higher stocking rate followed by) high plane of nutrition or lower stocking rate (good quality grass or 4 weeks prior to) before mating
Steaming up: ewes are fed good quality silage and concentrates (protein) are introduced gradually over the final 6 to 8 weeks (0.1kg 7 weeks from lambing, 0.2kg 6 weeks from lambing etc.)</td><td>2
2</td></tr>
<tr><td></td><td>(iii)</td><td>Briefly describe two advantages of flushing
Increased ovulation / increase number of multiple births or increase number of lambs born per ewe / increased conception rates (pregnancy) / increased embryo implantation rates / more regular heat periods</td><td>4+2</td></tr>
<tr><td></td><td>(iv)</td><td>Outline how to reduce mortality at lambing and give a reason for action
<table>
<tr><th>How to reduce mortality</th><th>Reason for action</th></tr>
<tr><td>Spread lime on pen</td><td>Reduce risk of infection</td></tr>
<tr><td>Add iodine to navel or adequate hygiene in sheds</td><td>Prevent navel or joint ill or infection</td></tr>
<tr><td>Ensure the lambs get colostrum</td><td>Provide immunity or antibodies</td></tr>
<tr><td>Ewes in good condition</td><td>Less risk of difficult lambing</td></tr>
<tr><td>Adequate supervision</td><td>Assist ewes in trouble lambing</td></tr>
<tr><td>Fostering multiple births higher than 2 lambs</td><td>Ewes only have 2 teats and can only rear 2 lambs</td></tr>
<tr><td>Equipment in one place</td><td>Have all equipment ready in case of difficult birth</td></tr>
<tr><td>Contact the vet or experienced person</td><td>Have number ready to call in an emergency</td></tr>
<tr><td>Infra-red lamp or heat box or glucose injection or lambing indoors</td><td>Prevent hypothermia or chill or predation</td></tr>
</table></td><td>2(2+2)
1(2+1)</td></tr>
</table>

Q15	**(a)(i)**	*Outline **two** advantages of grass - fed dairy animals* Healthier animals / better animal welfare / milk is higher in Beta-carotene (yellow butter) or fatty acids or vitamins or minerals / reduced cost of production / higher fat content / higher protein content / better flavour or taste / cheaper / less labour	**4+3**
	(ii)	*Draw a labelled diagram of **one** named method of grazing system employed by dairy farmer* *Named grazing system* - Paddock (rotational) / block / strip grazing / spokes of a wheel / leader-follower *(Zero grazing is not accepted)* Diagram 0, 3, 6 For 6 marks: diagram must show any three of the following; fencing, water supply, indication of animal movement, roadway, indication of grazing or previously grazed For 3 marks: diagram has two of the items listed above. Labels 3(3) - any 3 valid labels	**4** **D - 0, 3, 6** **L - 3(3)**
	(b)(i)	*Identify the cow's peak milk yield in litres / day* 26* (litres / day)	**6**
	(ii)	*Determine the estimated total yield for the cow using the following calculation* 26 X 220 = 5720 (litres) (If a candidate gives 5720 litres without showing any calculations they may be awarded 8m)	**4** **4**
	(iii)	*Outline the advice you would give in relation to culling of the cow* This cow's yield was lower (5720 litre) so may cull in favour of higher yielding cows	**2**
	(iv)	*Explain why the cow was dried off at 10 months* Give cow chance to recover body condition or attain correct BCS or allow calf to grow / getting ready or have energy for calving / give milk cells a chance to recover (repair) in udder / better quality colostrum / produce higher yield in following lactation / produce better quality milk in following lactation	**3**
	(v)	*State the length of the dry period (in days)* 60 (2 months)	**2**
	(vi)	*Describe how dairy cows were fed in early lactation* Good quality silage (75+% DMD) or kale / good quality (digestible) fresh grass / concentrates (14 – 16% protein)	**3**

Q16	**(a)(i)**	*Identify the month most suitable to make 1st cut silage and give a reason for your answer* *Month:* May or June *Reason:* Peak yield / plant is in leafy stage (vegetative stage) / very digestible	**4** **4**
	(ii)	*Shade onto the graph the proportion which represents the excess grass in summer months.* Shaded area between continous blue line and orange dash line	**2**
	(iii)	*Explain why a line graph is the most suitable way to present this data* Line graphs are used to track changes over short or long periods of time (trend) / when smaller changes exist, line graphs are better to use than bar graphs / line graphs can also be used to compare changes (over the same period of time for more than one group)	**2**
	(iv)	*Explain conserved (as hay or silage)* Grass that has been dried or fermented (in order to feed at a later stage)	**2**
	(b)(i)	*List **three** weather conditions essential for the production of top-quality hay* Sunny / warm / windy / dry (low humidity)	**3(3)**
	(ii)	*Explain **four** steps involved in the production of hay* Fertilise grass (min 6 weeks prior) / cut at correct stage (vegetative or inflorescence stage) / cut using a mower / cut in June or July / tedder grass / row the grass using a rower / until completely dehydrated / bale / move to storage shed	**3(4)+3**
	(iii)	*Identify the ideal moisture content of hay at time of storage* 18 (%)	**4**
	(c)(i)	*Identify each plants **A** and **B*** ***A*** = Ragwort ***B*** = Plantain or Ribwort	**4+2**
	(ii)	*State **one** agricultural impact plant A has on farming or the environment* Noxious plant (harmful to animals) / competes with crop / supports many species of wildlife (biodiversity)	**2**
Or			
	(d)(i)	*Identify each plant* ***C*** = Thistle ***D*** = Oats (wild)	**4+2**
	(ii)	*State **one** use for plant D* Animal feed / human consumption	**2**

Q17	**(a)(i)**	*Outline **two** advantages of technology in agriculture* Better use of chemicals / harvesting crops / sowing fertiliser (accurately) or saving fuel or saving fertiliser / reducing labour or time / more accurate data / increased animal yields / increased crop yield / better animal welfare / less leaching / tracking or monitoring animals or identification of disease or illness / other valid answer	**4+2**
	(ii)	*Briefly describe **two** reasons for the increased installation of robotic milking machines* Reduced labour or easier to use / increased milk yield as cows milked more often / quicker detection of mastitis or of milk quality / more consistency / better overall herd management / other valid answer	**4+2**
	(iii)	*Outline **two** potential disadvantages of using technology on Irish farms* Lack of practical knowledge / increased maintenance cost / technical difficulties / overuse of machinery can cause environmental damage / expensive to install / reduced employment / other valid answer	**4+2**
	(b)(i)	*Calculate the total bovine nitrogen figure for A for John's 1 – 2 year old cattle for 2020/'21* 40 X 57 = 2280 (kg) (If a candidate gives 2280 (kg) without showing any calculations they may be awarded 8m)	**4** **4**
	(ii)	*Calculate the total bovine nitrogen figure for all animals on John's farm for 2020/'21* 2990 + 1056 + 2280 + 57 + 65 = 6448 (kg) (If a candidate gives 6448 (kg) without showing any calculations they may be awarded 6m)	**3** **3**
	(iii)	*State if John achieved his target of 5% bovine nitrogen reduction* 6992 x 5% = 349.6 (kg) 6992 - 349.6 = 6642.4 (kg) This can be then rounded to 6643 (kg) or left as it is. (If a candidate gives 6642.4 (kg) or 6643 (kg) without showing any calculations they may be awarded 4m) Yes – John reached his target as he only produced 6442 (kg)	**2** **2** **2**
	(iv)	*State **two** possible environmental benefits if he achieved the 5% bovine reduction* Less chance of N leaching into rivers / reduced GHG emissions or ammonia emissions or less slurry / increased growth of clover in swards (allow N fixing bacteria to work)	**4+2**
	(c)	*Describe **three** ways all farmers could be more energy efficient* Install windmills / install solar panels / insulation of farm buildings (especially pig or poultry houses) / install LED's / install plate cooler to cool milk quicker / other valid answer	**4+1+1**

Q18	**(a)(i)**	*List **three** physical traits assessed by the DAFM when recommending seed varieties* Heading date / total yield / ground cover / spring growth / autumn growth / dry matter digestibility (DMD)	**3(4)**
	(ii)	*Identify which variety of perennial ryegrass produces the highest yield* Moyola (105 ton DM/ha)	**5**
	(iii)	*Identify which variety of perennial ryegrass produces grass in autumn* Moyola (107 ton DM/ha)	**5**
	(b)(i)	*Describe how Harry prepared the seedbed* Spray with total herbicide / plough (10 days after spraying) / spread lime and fertiliser or apply slurry after seeding / (power) harrowed (to produce fine firm seedbed) / roll prior to sowing / broadcast seed or sow seed close to surface or seed sown into old grassland or seed barrow / rolled again to achieve good soil to seed contact	**3(2)**
	(ii)	*State **one** reason why Harry has chosen certified seed to reseed his grassland* Min 85% germination rate / true to type / free from disease / free from weeds	**2**
	(c)(i)	*Genetic modification involves a number of steps – place these in correct order* *C - already given* **D / E / B / A**	**4(3)**
	(ii)	*State **two** advantages of GM crops* Contain more nutrients / are grown with fewer pesticides or herbicides or more environmentally friendly / usually cheaper than non-GMO / increased yield or less fertilizer / more resistant to disease or pests or weather conditions / tastier food / more predictable food supply or longer shelf life / medical benefits	**3+1**
	(iii)	*Briefly explain any **two** concerns that farmers may have about GM crops* May cause allergic reactions (due to altered DNA) or health risks or enter food chain / potential impact on non - target species / increased toxin levels in soil / exchange of genetic material with other plants or legal liability / may cause antibiotic resistance	**3+1**