Coimisiún na Scrúduithe Stáit

State Examinations Commission

Leaving Certificate 2021

Marking Scheme

Agricultural Science

Higher Level

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 marks 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.63 *Instructions to Examiners, 2021* (section 7.3, p.25), "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 manually 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 also explained in the table. These annotations will be seen on a script if viewed as part of the appeal process. 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.
×	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.

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 mark review the criteria descriptors against the marked work.

Higher 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	Excellent	Very Good	Good	Fair	Weak
Introduction and background research Suggested range between 300 and 500 words	Directly address, contextualises and clarifies the brief theme. Identifies and interrogates convincingly, a broad range of relevant, authoritative and credible sources of evidence. Clear understanding and shows extensive knowledge of theme.	Directly address the brief theme. Identifies and questions a sufficient range of relevant, authoritative and credible sources of evidence. Logically based on a very good knowledge and understanding of the theme. Very few errors.	Brief theme is reasonably addressed in a limited context. Identifies and interrogates a limited range of evidence with an over reliance on unproven data. Basic knowledge and limited understanding of the theme. Minor errors.	Brief theme is vaguely addressed with no clear context. Evidence presented is simplistic or confused. Evidence is only vaguely relevant to the theme. Vague understanding of theme. Major errors.	Brief theme is vaguely or completely misunderstood Little or no evidence presented. Evidence is not relevant to the theme. Little or no knowledge of the theme. Significant major errors.
20 marks	**18-20**	**14-17**	**10-13**	**6-9**	**0-5**

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	• Excellent - 9 - 10 marks • Very Good - 7 - 8 marks • Good - 5 - 6 marks • Fair - 3 - 4 marks • Weak - 0 - 2 marks	*Background research - research, sources and knowledge - 10 marks*	• Excellent - 9 - 10 marks • Very Good - 7 - 8 marks • Good - 5 - 6 marks • Fair - 3 - 4 marks • Weak - 0 - 2 marks

Section	Excellent	Very Good	Good	Fair	Weak
The investigative process Suggested range between 500 and 800 words	Identifies and provides a comprehensive description of investigative process undertaken. Clear, specific and valid hypothesis generated and tested. Clear ideas, concepts and theories make focused links between complex aspects of the task and learning outcomes of the specification. An accurate detailed description of how data was gathered.	Identifies and provides a sufficient description of investigative process undertaken. Specific and valid hypothesis generated and tested. Ideas, concepts and theories make some links between aspects of the task and to learning outcomes of specification. Description of how data was gathered to a high standard, with a few inaccuracies.	Identifies and provides a limited description of investigative process undertaken. Hypothesis generated and tested is valid but may lack some specificity. Ideas, concepts and theories make basic between some aspects of the task and to learning outcomes of the specification. Description of how data was gathered to a good standard, with some minor omissions / errors.	Details of the investigative process presented are simplistic / confused and only vaguely relevant to the theme. Simplistic hypothesis generated and tested. Ideas, concepts and theories make very vague links between aspects of the task and learning outcomes of the specification. Vague description of how data was gathered with major omissions / errors.	Little or no details of investigative process presented which is not relevant to the theme. Very simplistic hypothesis generated. Little / no evidence of ideas, concepts and theories presented. No real link with learning outcomes of the specification. Very poor description of how data was gathered which is also incorrect and /or contradictory.
25 marks	**23-25**	**18-22**	**13-17**	**8-12**	**0-7**

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	• Excellent - 11 - 12 marks • Very Good - 9 - 10 marks • Good - 6 - 8 marks • Fair - 4 - 5 marks • Weak - 0 - 3 marks	*Data collection undertaken - 13 marks*	• Excellent - 12 - 13 marks • Very Good - 10 -11 marks • Good - 7 - 9 marks • Fair - 4 -6 marks • Weak - 0 - 3 marks

Section	Excellent	Very Good	Good	Fair	Weak
Results, analysis, and conclusions Suggested range between 600 and 1000 words	The data is relevant, comprehensively analysed, interpreted, evaluated and presented optimally. Draws insightful, independent informed conclusions based on a relevant, critical and perceptive analysis of the evidence to arrive at justification of own position (hypothesis).	Very good interrogation and presentation of the data. Analysis, interpretation and evaluation of data to a high standard. Draws very good independent conclusions based on a critical and perceptive analysis of the evidence and clearly justifies own position (hypothesis).	Good interrogation and presentation of the data, but may lack some structure. Draws some independent conclusions based on a basic analysis of the evidence to justify own position (hypothesis), but lacks depth and structure.	Limited interrogation and presentation of the data. Very basic conclusions stated to justify own position (hypothesis). Conclusions made are flawed with limited evidence in support and superficial analysis / with significant inaccuracies. Repetition of material is evident.	Poor / confused / illogical interrogation and presentation of the data. Little or no evidence presented / or not relevant. Analysis is poor. Little or no conclusions made with very little evidence in support. Irrelevant materials used with repetition of material evident.
35 marks	**32-35**	**25-31**	**18-24**	**11-17**	**0-10**
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 • Excellent - 9 - 10 marks • Very Good - 7 - 8 marks • Good - 5 - 6 marks • Fair - 3 - 4 marks • Weak - 0 - 2 marks		*Informed judgement and conclusions following analysis - 15 marks* • Excellent -14 - 15 marks • Very Good - 11 - 13 marks • Good - 8 - 10 marks • Fair - 5 - 7 marks • Weak - 0 - 4 marks		*Knowledge and insights arrived at as a result of the study - 10 marks* • Excellent -9 - 10 marks • Very Good - 7 - 8 marks • Good - 5 - 6 marks • Fair - 3 - 4 marks • Weak - 0 - 2 marks	

Section	Excellent	Very Good	Good	Fair	Weak
Reflection on the study Suggested range between 150 and 200 words	Clear capacity to an in-depth, comprehensive and clear self-reflection on the completed study. Considers in depth the learning gained by and through engagement with the study. Considers in depth reliability, possible error(s) / changes / modifications while comprehensively relating back to the theme and hypothesis / action question.	Clear evidence of self–reflection on the completed work. Considers the learning gained by and through engagement with the study. Considers reliability, possible error(s) / changes / modifications while relating it back to the theme and hypothesis / action question to a high standard.	Some reflection on the completed work. Considers some of the learning gained by and through engagement with the study. Considers reliability, possible error(s) / changes / modifications with some linkage to the theme and hypothesis / action question.	Limited reflection on the completed work. Poor reference to the learning gained by and through engagement with the study. Poor consideration of reliability, possible error(s) and any possible changes / modification with limited linkage to the theme and hypothesis / action question.	Weak or no reflection on the completed work. Little or no reference to the learning gained by and through engagement with the study. No consideration of reliability, possible error(s) and any possible changes / modification very limited or absent. Weak linkage to the theme and hypothesis / action question.
10 marks	**9-10**	**7-8**	**5-6**	**3-4**	**0-2**
Award a single mark out of 10 for this section. In arriving at this mark consider the indicative content requirement below.					
Knowledge and insights arrived at as a result of the study - 10 marks			• Excellent -9 - 10 marks • Very Good - 7 - 8 marks • Good - 5 - 6 marks • Fair - 3 - 4 marks • Weak - 0 - 2 marks		
References	Full references for all sources used during the study and / or referred to in the report.	References for the majority 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 or referred to in the report.	Lack of proper or any referencing.in the study.
-	-	-	-	-	-
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	Excellent	Very Good	Good	Fair	Weak
Communication and innovation (This is not a distinct section of the report)	Excellent coherence, clarity, construction and organisation throughout the study. Adheres to the IIS structure. Communication of data and information is thorough, very well structured, relevant and accurate. The study exhibits an overall detailed knowledge involving critical thinking, deep insight, sharp focus, accomplished argument and is supported by a range of evidence and sources. Significant evidence of individual approach and innovation.	Very good coherence, clarity, construction and organisation throughout most of the study. Adheres to the IIS structure. Communication of data and information is well structured, organised and presented Study exhibits an overall good knowledge and evidence of critical thinking. Good evidence of individual approach and innovation.	The organisation and coherence of the study is of a basic level. Some of the points made may not be integrated well into the content and to the IIS structure. Communication of data and information presented is relevant which may have some errors / omissions. The study has reasonable knowledge and some critical thinking. Reasonable structure with some evidence of individual approach and innovation.	Organisation and coherence is limited and confused throughout the study. Study shows a limited understanding with limited valid and appropriate evidence which is not developed and connected and deviates from the IIS structure. Communication of data and information lacks clear focus and organisation, which has substantial errors / omissions. Limited knowledge and critical thinking. Poor structure with little evidence of an individual approach and innovation.	The study lacks organisation, coherence, context and clarity. Study shows very poor or no understanding with no evidence provided in support. IIS structure very poorly used or not used. Communication of data and Information contains only a few valid points, is of a very poor quality, with fragments of information of little or no relevance and is, littered with errors / omissions No evidence of an individual approach and innovation.
10 marks	**9-10**	**7-8**	**5-6**	**3-4**	**0-2**
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			• Excellent - 9 - 10 marks • Very Good - 7 - 8 marks • Good - 5 - 6 marks • Fair - 3 - 4 marks • Weak - 0 - 2 marks		

Section A		Answer any 7 questions 10 marks for each question Total for section is 70 marks	Marks
Q1	**(a)**	*Identify the following plants* *A* = Buttercup *B* = Thistle *C* = Dock (leaf)	 **2** **2** **2**
	(b)	*Distinguish between annual and biennial* *Definition of one of annual or biennial for 2 and two marks for the other with a named example* *Annual* - (plants that complete their lifecycle in) one year or valid description of life cycle *Some examples:* - Barley, Wheat, Oats, Peas, Beans, Maize or other valid example. *Biennial* - plants that complete their lifecycle in 2 years or valid description of life cycle *Some examples:* - Potatoes, Ragwort, Sugar beet, Carrots, Kale, Italian Ryegrass or other valid example.	**2** **1+1**

Q2	**(a)(i)**	*Explain Herbicide Resistance* (Chemical or herbicide) does not kill the (targeted) plant / inherited ability of a plant to survive and reproduce following exposure to herbicide that would normally be lethal to the plant species	**2**
	(ii)	*Explain how direct drilling and crop rotation could control wild oats* *Direct drilling* - minimum cultivation does not disturb dormant seeds	**2**
		Crop rotation - (helps control wild oats) by sowing dissimilar crops in the same place in subsequent years / wild oats unable to compete with different crop family / growing 3 or 4 crops in a rotation can break weed lifecycle	**2**
	(iii)	*Describe two reasons for control herbicide resistant wild oats* Decreased yield (or food production) / competition between wild oats and crop / seed can't be sold as certified seed / (weeds may develop herbicide resistance due to resist genes which) will lead to weeds being uncontrolled in a crop / wild oats contaminate the crop (leading to reduction in price from merchant) / lower amount of feed for animals or for brewing or milling or reduced profit / unsustainable and devastating for the environment or reducing biodiversity or wild oats become dominant / wild oats are a reservoir for pests or disease	**2(2)**

OR			
Q2	**(b)(i)**	*State a prediction for investigation* The water will (initially) travel up the compacted soil further than in the un-compacted soil (as the pore spaces are initially made narrower in compacted soil) / if soil is too compact capillarity will decrease	**2**
	(ii)	*Describe a suitable method* Put cotton wool or muslin cloth in open end of one tube (and place in retort stand) / obtain dry soil sample and compact one half of the sample / place equal amounts of compacted soil in open end of the tubes and un-compacted soil in the other open ended tube/ place both tubes in equal amounts of water / leave for a suitable valid time / measure or observe the level of water in each tube (or which tube had seeds germinate first if cress seeds used) / other valid method	**3(2)**
	(iii)	*Identify one way to improve accuracy* Record the exact mass (of the compacted an un-compacted soil using) an electronic balance / measure the height of the water (in the tubes using a ruler or use tube with graduations)	**2**

Q3	**(a)(i)**	*State the meaning of the symbols* *A* = Beware of bull / beware: livestock can be dangerous *B* = This is not a playground	**2** **2**
	(ii)	*State the function* *C* = castrating male animals/ tail docking *D* = to assist cows when giving birth (calving)	**2** **2**
	(iii)	*State one advantage of using piece of equipment to enhance sustainability* Castrate male animals on the farm to prevent unwanted breeding (of poor performing animals) / bloodless castration or tail docking reduces risk of infection / removes requirements for keeping bulls on farm / limited market for bull beef	**2**

OR			
Q3	**(b)(i)**	*Identify the farm machines A and B* *A* = Seed drill / combine drill / one pass system *B* = Zero grazer	**2** **2**
	(ii)	*Suggest one advantage of tractor fitted with tracks* Decreased compaction (due to increased surface area) / less damage to soil structure / can travel on wet land or better floatation / reduced risk of tractor turning over on steep hillsides or better stability / machine capable of pulling heavier loads	**2**
	(iii)	*State one way machine A enhance environmental sustainability* Reduces water run-off / reduces sediment loss / increases soil organic matter (C sink) / improved soil structure or reduces compaction / fewer number of passes leads to less emissions	**2**
	(iv)	*Outline one disadvantage of using B when feeding high producing animals* Stressed animals due to too much confinement (leading to reduced animal performance) / spoiling of cut grass - reduced intake / increased labour required to feed animals / increased capital investment on housing for animals / increased slurry storage requirement as animals housed all year round / bloat in livestock / lameness in livestock indoors	**2**

Q4	**(a)**	*Identify one way farm could become more energy efficient* Solar panels / increase amount of roof lights or sky lights or reduce the need for artificial light / install windmill / install bio-digester / rainwater harvesting / other valid answer	**2**
	(b)	*State two ways farmyard suited to economy of labour* Sheds are situated close together / farmyard is located close to main house / silage bales and pit are located close to the sheds / sheds are well designed for machinery access / cow housing close to parlour / roadway to grazing block	**2(2)**
	(c)	*Suggest two ways farmer could make farmyard more environmentally sustainable* *Cannot give the same answer to part (a)* Plant more trees or hedges (around the farmyard) to increase biodiversity or shelterbelts / sow wild flowers (on bank beside the shed) for pollinators (or biodiversity) or create a wildlife pond / cover the collecting yard to prevent any run-off when raining (bales on concrete) / cover the open lagoon to avoid it filling up quickly and becoming diluted / water harvesting to reduce water consumption / install bird boxes / install bat boxes / install insect hotels increase biodiversity / any energy saving measure that a student has not given as an answer to part (a) / pit silage instead of bales to reduce plastic waste	**2(2)**

Q5	**(a)**	*No marks for name of crop – crop must be referenced as named crop or within the question* *Describe two ways in which production contributes to sustainability* *Kale or stubble turnips* - protection of soil structure against soil erosion (from heavy rain) / reduced soil compaction or easier subsequent cultivation as roots which break up the soil / increased soil organic matter (whose main constituent soil organic carbon removes CO_2 from the atmosphere) / prevents mineral leaching as it uses up nutrients / act as a break crop for weeds, pests and diseases (so less chemicals required) / animals out-wintered or extends the grazing season - less slurry storage or less housing requirements or less winter feed / high protein - less concentrates needed / earthworm activity increased *Oilseed rape* -weed control -less herbicides required / strong tap root development - reduced soil compaction / improve soil structure which controls drainage and aeration (maintains optimum N mineralisation rates) / prevention of nitrogen leaching as it uses up nutrients / prevent soil erosion as root system binds soil / can be used as a biofuel reducing diesel requirements reducing the burning of fossil fuels *Miscanthus* - carbon neutral crop or reduces greenhouse gas emissions / low fertiliser requirement / no serious pest problems so pesticide use is limited / increases wildlife biodiversity	**2(2)**
	OR	valid answer for other named valid crop(s)	
	(b)	*No marks for named pest* *Describe damage by pest* *Kale or stubble turnip* -Flea beetle eats holes (in the emerging seedlings, stems of) leaves of plant / diamondback moth or white cabbage butterfly caterpillar feeds on the leaves of the crop / aphids suck sap damaging leaves / slugs or rabbits eat leaves of crop *OSR* - Bird damage over winter, pick at (small tender) leaves / flea beetle eat holes in leaves or larvae burrow into the stem *Miscanthus* - Larvae (caterpillar) of common rustic moth or ghost moth feed on roots of crop / wireworms bite holes in the stems or shoots	**2**
	OR	valid answer for other named valid crop(s)	

	(c)	*Describe two growth cycles of crop* *Kale (biennial plant) or stubble turnip* 1. *Germination* - cotyledon (seed leaf) emerge from the soil 2. *Vegetative stage:* true leaves produced (with uptake of nitrogen to stage where crop is in utilisation stage suitable for grazing in situ) *OSR* 1. *Germination and emergence* - cotyledon (seed leaf) emergence above ground 2. *Vegetative stage* - leaf development and side shoot formation (occurs once 1st true leaves emerge produces multiple side shoots) *Miscanthus* 1. After *establishment:* shoots emerge from underground rhizomes in spring 2. *Vegetative growth*: in summer producing leaf and stem growth (reaching a height of 3m)	**2(2)**
	OR	valid answer for other named valid crop(s)	

Q6	**(a)(i)**	Mitochondria*	**2**
	(ii)	*Outline two ways increase airflow through soil to allow respiration in the rhizosphere* Subsoiler or plough or harrow to break up soil or improve soil structure / drain land to prevent all available airspaces in soil becoming waterlogged (depriving the aerobic micro-organisms in the rhizosphere) / increase organic matter in soil to improve soil structure or increase number of earthworms (microorganisms) /add earthworms to soil, burrowing activity to increase airflow	**2(2)**
	(iii)	*Describe two ways soil compaction impacts physical properties of soil* *Structure* - soil compaction destroys soil aggregates *Porosity and density* - soil compaction reduces drainage / soil compaction reduces aeration *Temperature* - compacted soil leads to lower soil temperature	**2(2)**
		OR	
Q6	**(b)(i)**	*Describe one role animal respiration plays in the carbon cycle* Animals eat plants (to obtain glucose) and release carbon dioxide (in respiration) / (micro) organisms return carbon to environment when they decompose organic material	**2**
	(ii)	*Compare two effects of continuous tillage and permanent grassland on soil organic matter content* *Continuous tillage (Permanent grassland)* -decreased organic matter (increased organic matter) / stripping of nutrients or straw removal leads to less organic matter (more recycling of organic matter through crop presence and animal manures)	**2(2)**
	(iii)	*Suggest two ways a farmer increase amount of organic matter in soils* Grow perennial pasture (grass dominant) / sow catch or cover crops or cereal crops in crop rotation / spread FYM or spread slurry or organic fertiliser / min till / straw incorporation / addition of legume crops (green manure)	**2(2)**

Q7	**(a)**	*Explain biodiversity* Variety of plant and animal life in a habitat (ecosystem).	**2**
	(b)	*State one reason why biodiversity important on Irish farms* Soil or water conservation (protect freshwater resources) / maintenance of soil fertility / conservation of biota or pollination of plants / nutrient storage or recycling / increased ecosystem productivity / increased number of plant species or organisms / promote soil formation (and protection) / biological control or stable populations in ecosystem	**2**
	(c)	*Outline three ways to increase biodiversity on farm* Leave (whitethorn) tree in hedges or plant more native hedgerows or trees / cut 1/3 hedges annually (1 in 3 years) or cut hedges in pyramid shape to allow for nesting birds / cut hedgerows or meadows during designated time period / don't let animals drink out of water sources - decrease pollution or move drinking troughs away from drains / reduce chemical use / install bird or bat boxes or insect hotel / (identify and) control invasive species / sow wild flowers (to increase pollinators) or bird cover / sow multi-species swards (polycultures rather than monocultures) / presence of field margins or buffer zone or riparian zone or wildlife corridor / crop rotation / reduce intensive grazing practices	**3(2)**

Q8	**(a)**	*Briefly explain term conformation* Shape and muscle distribution of the animal	**2**
	(b)	*Calculate total amount John obtained for heifer* 395 + 20 = 415c/kg / (395 x 367) + (20 x 367) 367 x 415 = €1523.05 (If candidate just gives €1523.05 then award full marks (4m)	**2** **2** **(4)**
	(c)	*Calculate which heifers worth more* AA = 375 + 20 + 15 = 410 x 308 = €1262.80 AA = 380 + 20 + 15 = 415 x 321 = €1332.15 1332.15 + 1262.8 = €2594.95 - AA total 1597.75 + <u>1523.05</u> = €3120.80 - LM total *Heifer* - LM	**2** **1** **1**

Q9	**(a)**	*Explain the term genomic selection* Animals or plants selected based on their DNA (or genetic material) examined and compared to reference data.	**2**
	(b)	*Named enterprise – Dairy / beef / sheep / pigs etc.* *(There are no marks for naming enterprise) Points must be relevant to named enterprise. Two different forms of increased animal performance can be accepted)* *Outline two advantages for using genomically selected animals* Increased animal performance (milk yield / quality / LWG / EBI) / early identification of genetically superior animals for breeding / increased accuracy in prediction of outcomes of breeding programme and genotypic values of species (maximise hybrid vigour) / identify prolific sires to have increased offspring (increased profit) / allows breeders to consider effect of all markers in genome to calculate Genomic Estimated Breeding Value (GEBV)	**2(2)**
	(c)	*Describe genetic improvements based on physical traits* Farmer identifies trait (double muscle, udder, sound feet, conformation, good mouth, polled) then the farmer (selectively, deliberately) breeds from these (superior) animals (to achieve superior offspring) / breed from animals with better FCR which costs farmer less money (to feed leaving higher profit)	**2**
	(d)	*Discuss one way to reduce need for antibiotic use on farms* Better hygiene or management to prevent animals picking up disease / breed more genetically resistant breeds (e.g. TB, liver fluke, mastitis) / screen herd for different diseases and only give antibiotics if disease present / cull persistently infected animals so they don't pass on infections to other animals / use of vaccinations to prevent disease / operate a closed herd **or** breed own replacements or quarantine bought in animals to reduce the risk of disease entering the farm / identify high cell count cows and only treat identified cows with dry cow antibiotics	**2**

Q10	**(a)**	*Distinguish between artisan produce and niche market* *AP* - food produced in microenterprise with unique characteristics (usually handmade with a distinctive flavour) *NM* - small specialised market for a particular product or service	**2** **2**
	(b)	*Suggest two reasons why sheep dairy farming suited to Ireland* Ireland has large quantities of grass which is a cheap source of feed / ruminants have ability to convert (cellulose and protein in) grass to milk / temperate climate suitable for long grass growing season / sheep can be stocked on land unsuitable for cattle	**2(2)**
	(c)	*Compare % water in milk* Sheep's milk has 84% water compared to 87-88% water in cow's milk or sheep milk has less water than cow's milk	**2**

Q11	**(a)(i)**	*Distinguish between terms* *Duration of oestrus* = 18 - 24 hours / time that the cows are in heat or conception can occur or fertile period Oestrous *cycle* = 21 days / hormone controlled cycle of activity of reproductive organs in cows / they come into heat (ovulate) every 21 days or length of time between consecutive ovulations	**2** **2**
	(ii)	I*dentify where ovulation occurs* Ovary*	**2**
	(iii)	*Describe two advantages of AI in cattle or sheep or pigs* Cow / Sheep / Pig (no marks for name of animal) Increased choice of genetically superior sires available (top EBI or genomically tested bulls) (which will increase the EBI of the herd) / no danger of bull on the farm / disease control (closed herd) / do not have to change the bull (ram or boar) frequently to prevent inbreeding / proven fertility (rams, bulls, boars can be infertile even if fertile last year) / bulls have been performance or progeny tested (so farmers know the results of how that animal performs and can make an informed choice) / allows for double servicing of pigs to increase conception rates (increased litter size) / farmers know exactly due date for management / increased choice of breed or can choose different breeds (e.g. Holstein Friesian for genetically superior cows or heifers in the herd or easy calving Limousine for late calving cows or heifers / opportunity to use sexed semen	**2(2)**
OR			
Q11	**(b)(i)**	*Outline two differences* *Ruminant (Monogastric)* 4 stomach chambers (1 stomach) / digest cellulose (cannot digest cellulose) / regurgitation to chew material (no regurgitation of material) / fermentation (no fermentation) / ruminant dental formula (monogastric dental formula) or valid dental comparison between ruminant and monogastric / ruminants can synthesise amino acids (cannot synthesise amino acids)	**2(2)**

	(ii)	*Describe a named disorder or ruminant digestive system* *Points must match disorder named* *(There are no marks for naming condition)* ***e.g.*** *Bloat / Acidosis* *Symptoms* *Bloat* - gas build up in rumen and (left side of the) abdomen becomes distended (swollen) *Acidosis* - rumen stops moving leading to loss in appetite due to high levels of lactic acid produced *Treatment* *Bloat* - antacid or antifoaming solution / tube inserted through mouth to release gas / insert a trocar and canula (into the rumen) or trocar is removed and canula remains to allow gas escape *Acidosis* - dose with bicarbonate (bread soda) solution or magnesium oxide solution to neutralise the pH in the rumen *Prevention* *Bloat* - Limit amount of time spent grazing in early spring or provide additional fibre (silage) / antifoaming treatment in the water / limit grazing on high clover swards *Acidosis* - ensure adequate fibre fed especially on high concentrate diets / increase concentrate feeding levels gradually	**2** **2** **2**

Q12	**(a)**	*Identify the disease* Anaemia*	**2**
	(b)	*State the cause of disease* Lack of iron	**2**
	(c)	*Suggest a treatment* Iron injection	**2**
	(d)	*Describe two biosecurity practices* Closed herd - breeding own replacements to prevent buying in stock to prevent any disease being brought into the farm or quarantine bought in stock /shower in and out - all work personnel to shower in and out on entry and exit to farm to prevent any disease being brought in or out of farm / disinfect equipment to prevent any disease being brought on to the farm / restrict visitors - can't have been in contact with pigs in (previous 72 hours) / isolation sheds for sick animals to prevent further spread of disease from sick animal / staff training to ensure all biosecurity measures are adhered to / use of AI to decrease risk of disease transmission from buying in boars / intradermal vaccinations which reduces risk of disease entry at needle point / operate all in all out system which allows for wash, dry, disinfect, dry system to take place	**2(2)**

Section B		Answer any 3 questions 50 marks for each question Total for section is 150 marks	Marks
Q13	**(a)(i)**	*Identify one named plant from article which can fix atmospheric N* (Red or white) clover or legumes	**4**
	(ii)	*Outline two management practices to overcome challenges of growing multi-species swards* Rotation grazing or named rotational grazing system (21-28 day rotation), encourage growth of grass, clover and herbs / correct nutrient application to encourage growth of sward / spray weeds with herbicide, till and spray again when re-seeding / sow multi-species swards in spring time or optimum soil temperature (to allow for correct soil temp for establishment) / topping or mixed grazing or targeted weed control to control weeds without killing sward	**4+2**
	(iii)	*Name of grazing system* Rotational or paddock grazing system / block grazing system (3 - 4 days) / strip grazing / zero grazing / mixed grazing	**4**
		Outline two advantages Gives the sward time to recover from grazing (21 - 28 days - ideal 25 days) (without affecting forage quality) / doesn't allow for over grazing of sward or selective grazing of more palatable herbs or prevents dominance of one species / minimal damage to soil structure (reduced poaching) / sward is most digestible or leafier grass (high intake and high production milk yield and milk quality)	**4+2**
	(iv)	*Addressing farmers with plan including at least 4 benefits* *(Only one point can be accepted in relation to increased profit or reduced costs)* By using multi-species swards you will increase your butterfat and protein content in your milk which will give increased price for your milk (increased profit) / the clover or chicory will increase the protein in the feed which will increase productivity (milk yield, LWG, protein in milk) / clover will fix nitrogen which will reduce the artificial nitrogen requirement **/** which will reduce fertiliser costs (or increase profit or less tractor use) / clover is better for the environment as less ammonia will be released into the atmosphere or lost as nitrates into the water sources / multi-species sward will increase biodiversity on the farm (improve the sustainability) / increased palatability of the sward leads to increased intake and increased yields / some of the herbs (chicory and plantain) are deep rooting plants which provide drought resistance / chicory and plantain can reduce the effect of intestinal worms / multispecies sward has increased mineral content vs PRG only / uniform growth of sward throughout the season (vs peak growth in production) / increased ewe milk production or lamb weight gain in flocks	**4(2)**

	(v)	*Investigation to determine the botanical composition of a multi-species sward* Quadrat / throw at random / plants identified using a plant key / record each of the plants in each quadrat / min 10 times or repeat / estimate the % of each plant in the sward	**4(4)**
		WITH EITHER	
	(b)	*Explain the role each of the following in nitrogen cycle* *Nitrobacter*: (bacteria which) converts nitrite ions to (usable) nitrate ions (which are available for plant uptake) *Nitrosomonas*: (bacteria which) converts ammonium ions to nitrite ions *Denitrification:* nitrates are converted to nitrogen gas or nitrogen oxide.	**3(2)**
		OR	
	(c)	*Evaluate impact of three different crop management practices on all animals living in the farms ecosystem* *Reference must be made to at least two different types of animal, where impacts may be positive or negative* Chemical use (herbicides, pesticides, fertilisers) can kill pests but also non targeted beneficial species or application can increase yield of fodder for livestock / crop rotation to reduce the number of plant and animal pests or improves small animal numbers (biodiversity) or improves quality of feed for livestock / cultivation practices can increase earthworm number due to improved soil structure or decrease numbers due to named cultivation process / seed selection or multispecies or catch crops could increase pollinator numbers or bird cover or increase forage for livestock or monoculture can reduce variety of insect and animal species / draining the land reduction of animal pests or mud snail which is primary host of liver fluke or increased availability of land for livestock forage / leave wildlife corridors at the edges of fields to increase biodiversity / harvesting (or cutting or topping or grazing practices) removes habitat for wildlife or provides fodder for livestock / spreading FYM or slurry can increase earthworm numbers	**3(2)**

Q14	(a)	*Compare two different systems of animal production for a chosen livestock enterprise for an identified stage of the production cycle* Candidate must name production system, examples - liquid v creamery milk, calf to beef v suckler beef, mid-season v early lamb or other valid production system comparison (no marks for naming systems). *Answers must match named stage in production cycle.*	**Housing 4+2** **Nutrition 4+2** **Production Targets 4+2**

Stage	Liquid Milk	Creamery Milk
Housing		
Pre or post calving	Housed in loose house or cubicles or slats or straw bedding during dry period and moved to cubicle house once calved / cubicles cleaned daily and lime put on mats to prevent bacteria (mastitis prevention) / well ventilated and draft free sheds	Cows housed in loose house or slats or cubicles or straw bedding prior to calving and then turned out to grass for grazing / cubicles cleaned daily and lime put on mats to prevent bacteria (mastitis prevention) / well ventilated and draft free sheds
Nutrition		
Pre calving	High quality silage (72%+ DMD) (autumn calving) and high levels of concentrates / pre calving minerals (lick)	Turned out to grass as soon as conditions allow by day with supplementary silage (72%+ DMD) and lower amounts of concentrates required / pre calving minerals (lick)
Post calving	High levels of good quality silage and concentrates required during peak yield and peak demand period	Turned out to grass as soon as conditions allow by day / Mg included in spring ration to prevent grass tetany / graze high quality sward in rotational system
Production Targets		
Pre or post calving	Higher price paid for quantity of milk / higher yielding cows (Holstein Friesian or British Friesian or valid yield)	Quality of milk essential - higher price paid for %fat and protein of the milk / breed with high milk solids (Jersey cross or valid example)

OR		
Stage	**Calf to beef**	**Suckler Beef**
Housing		
Birth to first winter (including weaning)	Clean straw bedded / well ventilated and draught free / penned according to age / isolated on arrival / calf hut or shelter / clean water supply / out on pasture	Housed with mothers on straw bedding until turnout or creep system / out on pasture / well ventilated and draft free / clean water supply
First winter to second winter	Well ventilated and draught free /grouped according to size / slats (straw bedding) / space in shed 1.2 - 1.5 m^2 per head or adequate feeding space / clean water supply	Well ventilated and draught free /grouped according to size / slats (straw bedding) / space in shed 1.2 - 1.5 m^2 per head or adequate feeding space / clean water supply
Second winter to slaughter	Well ventilated and draught free / grouped according to size / slats (straw bedding) / space in shed 2 - 2.5 m^2 per head or adequate feeding space or 4m^2 for straw bedding / clean water supply	Well ventilated and draught free / grouped according to size / slats (straw bedding) / space in shed 2 - 2.5 m^2 per head or adequate feeding space or 4m^2 for straw bedding / clean water supply
Nutrition		
Birth to first winter	Colostrum / milk or milk replacer or bucket fed / creep from 7 - 10 days / hay (silage or straw) or scratch factor / grass (leader follower)	Colostrum / milk from mother / creep from 7 - 10 days / hay (silage or straw) or scratch factor / grass or named grazing system /
First winter to second winter	Silage (72%+ DMD) / concentrates (14-16%) if necessary / Grass (rotational grazing)	Silage (72%+ DMD) / concentrates (14-16%) if necessary / Grass (rotational grazing)
Second winter to slaughter	Silage (72%+ DMD) / concentrates (14%)	Silage (72%+ DMD) / concentrates (14%)
Production targets		
Birth to first winter	35 - 40kg at birth / weaning at 90kg / First summer 0.8kg ADG	40-55kg at birth / First summer 1.2kg ADG / 300kg at weaning
First winter to second winter	220kg at housing / 0.6kg ADG / 320kg at turnout / Second summer 0.8 -1.2kg ADG /	0.7kg ADG / 400 kg at turnout / Second summer 1-1.2kg ADG
Second winter to slaughter	550kg at housing / 0.8-1.2kg ADG / 550 - 650 kg at slaughter	550-600 kg at housing / 1 - 1.2 kg ADG / 650 - 750 kg cattle

OR		
Stage	**Midseason lamb**	**Early lamb**
Housing		
Pre lambing	Ewes housed 8 weeks prior to lambing in pens according to number of lambs they are carrying / housed on clean straw bedding or slats / triplets are housed close to singles for ease of fostering	Ewes housed 8 weeks prior to lambing in pens according to number of lambs they are carrying / housed on clean straw bedding or slats / triplets are housed closed to singles for ease of fostering
Post lambing	Ewes and lambs are put into single pens for bonding then into hardening off pens prior to letting out to the field	Ewes and lambs not let out after lambing - housed indoors until slaughter for the Easter market / housed in single pens at lambing / moved to hardening off pens
Nutrition		
Pre lambing	Ewes are steamed up prior to lambing (0.1kg 7 weeks from lambing to 0.7kg at lambing, split in two feeds) / good quality silage (75%+ DMD) / mineral lick (nutrient bucket)	Ewes are steamed up prior to lambing (0.1kg 7 weeks from lambing to 0.7kg at lambing, split in two feeds) / good quality silage (75%+ DMD) / mineral lick (nutrient bucket)
Post lambing	Lambs get colostrum, milk and turnout to grass and creep fed concentrates / ewe have grass only after a few weeks of concentrate feeding	Lambs get colostrum, milk concentrates (high levels) and silage / ewes on silage and concentrates
Production targets		
Pre or post lambing	Ewes BCS 3.5 at mating and 3 at lambing /Aim to have 1.8 lambs weaned per ewe/ finish in 16 weeks at liveweight of 42kg (KO 21kg)	Ewes BCS 3.5 at mating and 3 at lambing /Aim to have weaning rate of 1.7 lambs per ewe / target finishing weight 42 kg (KO 21kg) in 12-14 weeks or for higher priced Easter market
OR		
Other valid comparisons		

	(b)(i)	*Identify the following breeds* *A* = Suffolk *B* = Shorthorn *C* = Belgian blue *D* = Texel	**4(1)**
	(ii)	*Compare characteristics of two named breeds of either pig or horse or poultry* *(No direct marks for naming the breeds)* Landrace - excellent ham / high carcase weight / good milk production / high prolificacy / good conformation Large white - high growth rate / high lean meat % / good terminal sires / good uniformity of pigs / prolific / good at converting feed / good conformation **Or** other valid names and associated valid characteristics	**2(2+1)**
		OR	
		Rhode island red - hardy breed / produce well on marginal feed / lay 200 to 300 eggs per year (prolific) / produce large eggs / eggs pale brown colour (market demands) / produce medium weight eggs White leghorn - lay 280 to 320 eggs per year (very prolific) / produce white eggs / produce heavy eggs / can withstand cold conditions (ideal for free range or organic enterprises) **Or** other valid names and associated valid characteristics	**2(2+1)**
		OR	
		Irish sport horse - athleticism / jumping ability / courage / intelligence / soundness Irish draught horse - versatile / powerful stride / athletic animal / excellent conformation quality **Or** other valid names and associated valid characteristics	**2(2+1)**

	(iii)	*Discuss two factors taken in account when considering welfare of calves in a calf to beef enterprise from birth to weaning* Housing or freedom from discomfort or fear or distress or free to express normal behaviour - good ventilation to ensure calves are breathing in clean fresh air or prevention of pneumonia or adequate space to prevent disease/ draught free - calves are not lying in a draught - reduce incidence of pneumonia / clean dry bedding to prevent navel (joint) ill or scour / no sharp edges in calf house - prevent any cuts Nutrition or freedom from hunger or thirst - calves get colostrum at birth - laxative or energy or warms up calf or antibodies to prevent disease / milk (milk replacer) - provide energy and growth of calf / provide calf with meal and hay from 10 - 14 days - scratch factor - develop rumen / clean water or constant access to water Health or free from pain, injury or disease - vaccination (IBR or Pneumonia or Scour or Clostridia disease) - if these disease are problem on your farm / dehorning - prevent injury to others when older, dehorning at young age minimises stress, local anaesthetic required (illegal to dehorn calves over the age of 14 days without an anaesthesia / castration of young calves (3 -6 weeks of age) - use sterile rubber bands to prevent infection / dipping navel in iodine to prevent infection	**2(3)**
	(c)(i)	*Determine liver score and state one conclusion re liver health* *Liver score*: 3 / 5 *Conclusion*: animal has liver damage due to fluke being present in the past or live fluke present and; Not treated (misdiagnosed) - the animal was not given an anthelmintic (dose / drench) to treat the parasitic load **or** Re-infected after treatment - animals were treated but were re-infected again from the pasture after treatment **or** Treated with product that only kills adult fluke leaving the immature fluke to survive and mature causing liver damage **or** Fluke resistant to product - with continued use of the same product or under dosing of animals - fluke can becomes resistant to a product (need to rotate products regularly and ensure animals are weighed to give accurate amounts of dose for their weight **or** / liver abscess present / Liver damage from animals being fed a high concentrate diet (e.g. 16 month bull beef) causing a decrease in animal performance **or** Infection (e.g. TB or navel ill) - which leads to a reduced animal performance	**3**

	(ii)	*Determine lung score and state one conclusion re lung health* *Lung score* - 3 *Conclusion:* heifer has extensive lung damage as a result of pneumonia (viral / bacterial infection) - lung lesions result in reduced performance of the animal	**3**
	(iii)	*Overall comment on health of seven animals* There is a lot of liver damage across the age of cattle on the farm and the lung health is better for the majority of cattle	**4**
	(iv)	*Provide health plan with three recommendations* Farmer should get fluke tested for resistance / faecal egg sample to determine need (some animals have liver score of 3 which shows live fluke present) / dose for all stages of fluke to ensure all stages of fluke are killed (live fluke - score 3 - animals may have been dosed but it may only have been effective for adult fluke and immature fluke survived) / farmers should dose according to weight (scores 2+ showing liver damage - if the animals don't receive the correct amount of dose for their weight (under dosing)-dosing in autumn (pre-housing or during housing) / leader follower grazing system -young animals go first on clean pasture as they are less susceptible to parasites / appropriate diet to prevent liver abscess / spraying navel to prevent live abscess *Reference to life cycle of liver fluke for the following:* Lime land to increase soil pH / drain land / ducks or geese (biological control) / fence animals away from water source (to control mud snail which is secondary host of liver fluke) The majority of cattle have scored 1 indicating healthy lungs so pneumonia is not a major problem so vaccination is not required (or continue vaccination programme). Good ventilation to prevent respiratory illness / good hygiene to prevent infection / isolating sick animals / quarantine bought in stock	**3(2)**

Q15	**(a)(i)**	*State a hypothesis for investigation* Applying organic fertiliser in autumn will increase grass yield (DM%), earthworm population and spring nutrient availability	**3**
	(ii)	*Identify variables* *Independent*: application rates and source of organic fertiliser	**3**
		Dependent: grass DM% and earthworm population and spring soil nutrient availability	**3**
	(iii)	*Describe two ways to spread slurry while reducing impact on environment* Trailing shoe or shallow injection Reduces the surface area of grass covered by slurry (less contamination) (allows for extended grazing) - placed on soil under the surface of the grass / less ammonia emissions Dribble bar More precise delivery of nutrients - less chance of nutrients leaching (more N retained by grass sward) (less chemical fertiliser required) Umbilical system (with dribble bar) Less compaction due to less travelling on land or less fuel used / widens window of slurry application – better soil conditions at time of application / more precise delivery of nutrients - less chance of nutrients leaching (more N retained by grass sward) (less chemical fertiliser required) Do not spread in wet weather or during rainfall / do not spread close to waterways / spread during the growing season / do not spread on waterlogged or frozen ground / spread in line with Nitrates Directive	**2(4)**
	(iv)	*Investigation to determine %DM of grass* Cut a number of grass samples from the different treatment areas / Record mass of beaker. Add grass to the beaker and record the mass. Determine mass of grass sample. / place the grass in an oven at 100^{o}C (for 15 mins or longer at lower temp e.g. 60^{o}C for 48 hours) or microwave at short intervals / repeat weighing until you get a constant mass / calculate the mass of the grass by subtracting the mass of the beaker from overall mass / *Calculate the DM% of the grass by putting mass of dry grass over mass of fresh grass multiply by 100/1 / Calculate the average DM% for each treatment. **Compulsory point*	**3(4)**
	(v)	*List one systematic error* Electronic balance not calibrated properly / did not calculate mass correctly / oven not at appropriate temperature / excess water was not removed before weighing	**3**

(b)(i) *Identify which treatment*

FYM - High **3**

(ii) *Calculate*

Marks awarded for correct calculation based on the answer given by candidate in part (i)

Solution 1	***Solution 2***
Where the start point is taken as the November values 3700 – 1400 = 2300 kg DM / ha 3400 – 1000 = 2400 kg DM / ha	*Where the start point is taken as the November control value for both* 3700 – 1000 = 2700 kg DM / ha 3400 – 1000 = 2400 kg DM / ha
There will be 2300 kg DM in the FYM high treatment compared to the control treatment which gives 2400 kg DM /ha)	There will be 2700 kg DM in the FYM high treatment compared to the control treatment which gives 2400 kg DM/ha

3+2

(iii) *Outline advice re source and application rates of organic fertiliser*

Advice would be for farmers to put high levels of FYM (25 ton / ha) on the land in autumn to get good quality grass at turnout

(The highest Kg DM per ha availability in Feb for early turnout in spring was in the FYM High (25 ton / ha) treatment as there was 3200 kg DM per ha available for grazing)

4

(iv) *Three specific recommendations*

Applying FYM provides more DM per ha compared to slurry / lower amounts slurry provide more DM than high amounts / higher amounts of FYM provide more DM than lower amounts until March / to ensure high DM in March apply any organic fertiliser in autumn / high slurry shows limited impact on DM availability in March

All statements above must be backed up by relevant evidence from graph

3(2)

Q16 **(a)(i)** *Calculate which farmer earns higher price for milk*

Dan's calculation *Marks given for totals underlined*	*Joe's calculation*
1803 X 5.48 = <u>9880.44</u> 2292 X 3.35 = <u>7678.20</u> 50,000 x 0.04 = 2000	9316 + 6830 - 2000 =14,146
Total = 15,558.64	Total = 14,146

(4,2,0)

**4m for correct totals, deduct 2m if method correct but totals incorrect*

Higher Price - Dan **2**

(ii) *Describe two ways to increase % fat and protein content of milk*

Breeding high EBI cows (to increase the % fat and protein) / clover in sward (will increase protein in milk) / good quality silage (72 - 75% DMD) to (increase milk solids) / good digestible sward (PRG) to increase milk solids / cross breed with jersey cows (hybrid vigour)(to increase milk solids) / feed high (protein) concentrate or named example (to increase milk protein) / increase fibre content of diet for indoor milking (for increased butterfat) **2(3)**

(iii) *Three recommendations to reduce TBC and SCC in milk*

**At least one point from each of TBC and SCC*

Reducing TBC

Lime on cubicles / change liners of clusters in milking parlour regularly (twice a year) / cool milk to <4^{o}C as quickly as possible / add plate cooler / milk filters (to reduce amount of debris in milk) / teat dipping (pre and post milking) / dry cow therapy (teat seals) (to kill any bacteria in udder)(prevent bacteria from entering the udder) / clipping of cows tail (to keep the teats and udder clean) / washing and drying udder prior to milking (to remove any excess dirt) / (hot) washing milking parlour or bulk tank (with dump temperature above 50^{o}C) (to kill any bacteria in milk lines (without use of chlorine based sterilising products which can leave trichloromethane - TCM residue)

Reducing SCC **3(3)**

Lime on cubicles (to kill bacteria under the cows udder) / milk infected cows last to stop transfer of bacteria to other cows (disinfect clusters) / cull persistently infected cows or older cows with high SCC (identified by milk recording) (to prevent disease being passed to other cows) / teat dipping (pre and post milking) (to kill any bacteria present on or in the cow's teats) / to identify cows with cell count (clinical or sub-clinical) - withhold milk from infected cows / clean, dry bedding (straw) in dry cow house (to reduce amount of bacteria cow is exposed to) / dry cow antibiotics (teat seal) (to kill any bacteria present over a period of time) (prevent bacteria from entering the teat) / 'strip' fore milk to detect any signs of clinical mastitis and treat cow with antibiotics

	(b)	*Investigation in relation to milk quality over time* Place equal amounts of one milk sample into a number of sterile containers / test samples (average) immediately / leave the other samples to test over time – (e.g. test at 5 hours, 24 hours, 48 hours, 72 hours) / Add (1 cm^3) of Resazurin to samples / place in water bath at 37^oC for 15 minutes / record colour of samples / result (State at least two colours and corresponding conclusion from: Fresh – blue – good quality (low TBC) / Blue – deep mauve = good / Deep pink = fair / Light pink = poor / White = poor *Points may be presented on a labelled diagram*	**4(3)**
	OR	*Joe could do a total bacterial count on the sample:* Carry out a serial dilution of one milk sample by adding 1ml of milk into 9ml of sterile water and shake to mix. Then take 1ml from this test tube and add to 9ml of sterile water and shake. Repeat this for 4 more test tubes. / take 1ml of milk from the last test tube and place on a prepared nutrient agar plate under aseptic conditions. Repeat this 3 times for accurate results / spread the milk around the plate using a plate spreader/ leave one agar plate unopened as a control. /place in incubator for 72 hours at 25^oC. / remove plate and record number of bacteria colonies on the plate and multiply by 10^6 to get the number of CFU's / ml of milk. / repeat steps 2 - 6 from same milk sample (e.g. at 5 hours, 24 hours, 48 hours, 72 hours) to determine the quality of a sample of milk over time / *Result:* There will be an increase in CFU's over - time as the number of bacteria in the sample multiply causing a decrease in quality of the milk. *Points may be presented on a labelled diagram*	
	OR	*There are other valid tests a student could also do* - % protein / % butterfat (Gerber method) / presence of thermoduric bacteria (serial dilution) / presence of antibiotics (Devlo test) / SCC - California Mastitis Test (CMT) / % Solids in a milk sample (excess water) *Points may be presented on a labelled diagram*	

		WITH EITHER	
	(c)(i)	*Outline how the European Union achieve top priorities* Low emission slurry spreading (LESS) / protected urea / extended grazing / increased forestry planting / rewetting bogs (carbon sinks) / (grants for) renewable energy sources / growing catch (cover) crop or clover min-till / high EBI cows or more efficient cows	**3**
	(ii)	*State one reason why dairy industry ensures sustainable development* Irelands unique selling points (USP) are: grass fed animals (excellent animal welfare or unique characteristics of produce) or family run farms	**2**
	(iii)	*Outline two characterises of Irish food composition based on grass-fed animals* Creamy yellow butter due to the increase Beta-carotene (in the grass) / yellow fat due to increased Beta - carotene (in the grass)/ increased CLA's / higher Vitamin A or E / higher omega 3 fatty acids or unsaturated fatty acids	**2(2)**
	(iv)	*Discuss two management practices to ensure quality, safe and traceable food* Quality assurance scheme minimum movement of animals or all movements recorded / bonus for in-spec cattle so producing cattle that meet market demands / up to date animal remedies record including withdrawal period of antibiotics (milk and meat) to ensure no antibiotics gets into the human food chain / feed good quality feed (digestible, leafy grass / good quality silage (72 - 75%) DMD) / breed high genetic merit animals which produce top quality milk or meat / complete an animal health plan to ensure animals are kept healthy with minimal amount of antibiotics used or dose animals for parasites to ensure good animal welfare when required (faecal egg counts should be used to inform decisions on dosing) or herd testing (TB or BVD or brucellosis) / all animals tagged or have cards (passport) to ensure traceability	**4+4**

		OR	
	(d)(i)	*Outline two advantages of using virtual fencing* Lower fencing cost / labour saving / controlled conservation grazing / better (easier) pasture management / riparian protection / increased (or uniform) soil fertility / increased production	**2(3)**
	(ii)	*List one disadvantage of using virtual fencing* Animals can become stressed / expensive to install / loss of collars or technology stops working or livestock ignore warnings	**4**
	(iii)	*Describe two grassland management practices to ensure cattle reach target weight in second summer* Rotational grazing (21 day) - fresh digestible grass available to the cattle every day (to ensure production target (1.0 - 1.2kg) LWG) / clover in sward - protein (for increased LWG) / post grazing grass is topped to ensure top quality digestible, (leafy grass for increased LWG) / N fertiliser (CAN, protected urea) spread post grazing to increase growth of leafy, digestible grass for (increased animal performance (LWG)) or fertiliser based on soil reports	**2(2)**
	(iv)	*State one safety consideration during grassland management* Wear gloves and mask when handling fertiliser / be careful not to cut yourself with clippers when measuring grass growth / be careful when agitating slurry (do not enter shed, windy day, never be alone) / be careful when fencing using post drivers/ safety with livestock / or other valid answer	**3**

Q17	**(a)**	*Outline two procedures to be followed when taking soil samples for analysis* W shape / min 20 samples / stay away from water or feeding troughs or gateways / ensure cores are taken at correct sampling depth / don't sample a field until after 3 - 6 months after P and K application / don't sample field until 2 years after lime application / sample at the same time of the year to aid comparison	**2(3)**
	(b)(i)	*Determine the P and K soil indexes for field 2* *P* = 3 *K* = 4 *(both answers must be correct for 3 marks)*	**3**
	(ii)	*Suggest one reason why P and K indexes in field 1 are very different to field 2* *Field 1* Mainly used for silage production so there are no animals grazing the land so very little dung and urine or chemical fertiliser is on the land so little opportunity to build up P and K levels / pH is very low (5.3) which immobilises nutrients **OR** *Field 2* Main grazing block so there are animals grazing it constantly so there is dung and urine spread being added to the land allowing for increased P and K levels / pH is 6.0 (ideal) for nutrient availability	**3**

	(iii)	*Discuss the implications of low pH in field 1 in relation to liming and uptake of nutrients* **Need one point on liming and one on uptake of nutrients* Farmer needs to add 5 ton per ha lime to land / low pH 5.3 - reduced availability of nutrients to plants - reduced growth rates and decreased yield of crop / ions may become abundant in soil - may build up to toxic levels / activity of micro-organisms may decrease as optimum for activity is above pH 6.0 / when pH moves above 5.5 - more nutrients become available - optimum crop growth pH 6.5	**2(3)**
	(iv)	*Identify any two other macronutrients and state role in plant growth* • Sulfur - forms enzymes or assists in formation of plant proteins / closely associated with N uptake or efficiency • Calcium - formation of cell walls or cell membranes • Magnesium - helps capture sun's energy for photosynthesis / part of chlorophyll (molecule) / helps to activate specific enzyme systems • Nitrogen - main component of chlorophyll which traps light in photosynthesis / main component of amino acids or protein / leafy growth	**3+3+1 +1**
	(v)	*Outline two ways K levels can be increased on land* Spreading slurry / FYM / any named correct artificial fertiliser (e.g. 10:10:20, 18:6:12, potash etc.) / green manure	**4+2**
	(vi)	*Briefly describe two ways P leaching can be prevented* Create buffer or riparian zones around water sources (especially on heavy land) - sediment into water (P leaching) / correct application rates to prevent excess P in soil or based on soil test / cover crops to absorb excess P and prevent run off / apply P at correct time	**4+2**
	(c)	*Describe investigation in relation to cation exchange capacity of a soil* Add (high pH) soil to filter paper in a funnel with a clean dry beaker underneath / add potassium chloride (or potassium ions) solution (drop by drop) to the soil / collect the water that filters from the soil into the beaker (leachate) / test the leachate for calcium by adding (10 drops) ammonium oxalate to the leachate / white precipitate forms, calcium is present / discard the leachate and rinse the beaker with deionised water / repeat the experiment by adding more potassium chloride to the soil and testing the leachate for calcium / repeat the experiment until the leachate does not test positive for calcium *(Points may be presented on a labelled diagram)*	**3(4)**

Q18	**(a)**	*Discuss the effect of each of the following on a name crop to include two points under each heading* *Named crop: Barley / Wheat / Oats/ Potatoes / Grass etc.* *No marks awarded directly for naming the crop* *Soil Quality* Drainage and aeration: higher % of water results in less air in the soil so it will decrease the productivity of the crop (reduced yield) / texture: very high % of sand and little clay in the soil, it won't be as fertile so it will have a reduced yield or if there is not enough water the in the soil the plant will suffer from drought stress and cause a decrease in crop yield or high clay % promotes fertility or drought resistance which increases yield / pH 6.0 -6.5 (potatoes pH 5.5) - higher or lower pH may result in a reduced crop yield as it may affect nutrient availability or potential for metal toxicity or efficacy of herbicides or nitrogen fixation by leguminous crops / root support - if soil quality is poor the plant may not be able to develop a good root structure which will cause a reduction in crop yield / temperature: warm soils have earlier germination and faster growth rates *Crop Preservation* Crops should have certain moisture content at harvest (e.g. Barley ~ 15%) - otherwise seeds will heat and germinate and spoil - may need drying after harvest or suitable storage (ventilation, cool conditions) for preservation / acid treatment (or crimping) to prevent germination of seed for long term storage of feed (throughout the winter) or treated with sprouting inhibitor / control of vermin to prevent losses or damage to crop **OR** Harvest in dry conditions to prevent rot / store in darkness or cool conditions or frost free or well ventilated to prevent spoilage and losses / vermin free to prevent spoilage and losses / sprout inhibitor to prevent losses / remove damaged tubers to prevent spoilage **OR** Fermentation of grass (lactobacillus bacteria feed off the sugars in the grass) to produce lactic acid which decreases the pH to 4 - fermentation process to preserve the grass (silage) - leads to increased DMD of the silage or palatability / dehydration (hay) reduces moisture content below 20% preventing spoilage (or loss) / cut in afternoon or double chop or leafy grass for increased sugar or wilting grass to increase sugar or reduces nitrates for DMD or palatability / airtight silage pit (or bales) to ensure anaerobic conditions to prevent spoilage (or loss) / additive to promote fermentation for high DMD or palatability **negative effect on productivity may be accepted as alternative to points above*	**2(2)** **2(2)**

	(b)	*Discuss three challenges in relation to sustainable intensification* Have to use some of her tillage land (14 ha) for the extra 35 cows so she will produce less grain so she will have to import feed for her cows which will affect the sustainability of the farm / increased slurry or silage effluent or feed or dairy washings or milk) storage required / extra housing for extra cows and calves on the farm / fencing main grazing block for extra cows (bigger paddock sizes required) or extra water troughs or widen roadways (camber road) / increased use of N for growing grass - farm may run into trouble with nitrates derogation or soil compaction / effective grassland management required (grass monitoring and measuring) to allow for extended grazing / breeding top EBI cows to produce top quality milk and reduce requirement for too many replacements / incorporation of adequate amounts of white clover to reduce N requirement and increase protein % in milk / increased energy efficiency - solar panels / ensuring biodiversity on the farm to ensure environmental sustainability / low emission slurry spreading to reduce the amount of ammonia emissions being lost and more productive land / extra labour required for milking, calving, livestock management	**3(3)**

	(c)(i)	*Explain drying off period* Period of time when cow is not producing milk (60 days)	**4**
	(ii)	*Outline one reason for negative energy balance in early lactation* Daily requirement of a cow cannot be met by the energy she consumes (cows cannot physically eat enough to meet the demands of lactation) so cow milk's off her back	**4**
	(iii)	*Suggest two ways to limit negative balance in early lactation* Feeding concentrates / correct BCS at calving (3.5) / feeding good quality grass (silage 72% + DMD)/ grazing on paddocks close to yard to minimise energy usage from movement or zero grazing	**2(3)**
	(iv)	*State one implication for breeding season if cow in negative energy balance* Cow's reproductive cycle may not have started since calving - not ovulating - won't go in calf or longer calving interval	**4**
	(v)	*Describe feeding regime for mid lactation* In mid-lactation cows can produce milk on a grass only diet / rotational grazing keeps highly digestible grass fed to the cows at all times / no requirement for concentrates at this stage	**2(3)**
	(vi)	*State length of lactation period* 305 days	**4**
	(vii)	*Briefly describe two methods of heat detection* Observation - farmers observe the cows 3 to 5 times per day (not at milk times) to see if any cows are in heat or standing heat / tail paint - a strip of paint is painted onto the tail head (clipped) and when she is in heat the paint will rub off on mounting / pedometers - monitors cows activity, an increase in activity will indicate the cow is in heat / scratch cards - placed on the tail head of the cow and when the cow is mounted the card will be scratched indicating the cow is in heat / Kamars pressure sensor devices with built in timing mechanisms that are activated on standing heat / vasectomised bull - bull that has all the hormones of an intact bull but can't put the cow in calf is run with the herd, an increase in interest in a cow from the bull will indicate the cow is in heat or chin ball / milk progesterone - if the animal is in heat the milk progesterone levels are low / robotic milking heat detection sends message or drafting system / or other valid methods of heat detection for other livestock enterprise	**3+2**