Index No.:_____ AM05/I.25m

L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2025 FIRST SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	I
DATE:	6th May 2025
TIME:	9:00 a.m. to 12:05 p.m.

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions. Write all your answers in the spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated.
- You are reminded of the necessity for good English and orderly presentation in your answers.
- In calculations you are advised to show all the steps in your working, giving your answer at **each** stage.
- The use of electronic calculators is permitted.

For examiners' use only:

Question	1	2	3	4	5	6	7	8	**Total**
Score									
Maximum	10	10	16	14	12	13	11	14	**100**

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1. This question is about protein structure and function.

   a. Draw the general molecular structure of an amino acid, ensuring that **all** key atoms and functional groups are accurately represented.

(2)

   b. The variable region of an amino acid, known as the R group, determines the amino acid's chemical properties. Some R groups are non-polar. Explain how the presence of non-polar R groups influences the folding of a polypeptide chain in an aqueous environment.

_____

_____

_____

_____

_____ (3)

   c. Collagen is a fibrous protein, whereas insulin is globular. Describe the structural differences between these proteins and explain how these differences relate to their functions.

_____

_____

_____

_____

_____ (3)

   d. Denaturation happens when a protein loses its specific three-dimensional shape.

      i. Identify **TWO** types of weak bonds or interactions that are typically broken during protein denaturation, leading to a change in its three-dimensional structure.

_____ (1)

      ii. Name **TWO** denaturation agents or conditions that can disrupt these weak bonds and cause this structural change.

_____ (1)

(Total: 10 marks)

2. Provide a brief explanation for the following traits. In each case, mention **ONE** example to support your explanation.

   a. In some arthropods, modified chelicerae assist in more effective prey capture.

_____

_____

_____

_____ (2)

   b. Echinoderms evolved radial symmetry as adults, as this is advantageous for their mode of life.

_____

_____

_____

_____ (2)

   c. The terrestrial niche of oligochaetes reduced selective pressure for pronounced cephalisation.

_____

_____

_____

_____ (2)

   d. Some cnidarians exhibit varied morphological forms at different stages of their life cycle, thereby minimising intraspecific competition.

_____

_____

_____

_____ (2)

Question continues on the next page.

e. Some Platyhelminthes possess hooks at their anterior end.

_____

_____

_____

_____ (2)

(Total: 10 marks)

3. This question is about the human digestive system.

a. Each region of the gut has its own unique characteristics.

i. Complete Table 1 by labelling the **FOUR** major layers of different cell types that form the wall of the gut.

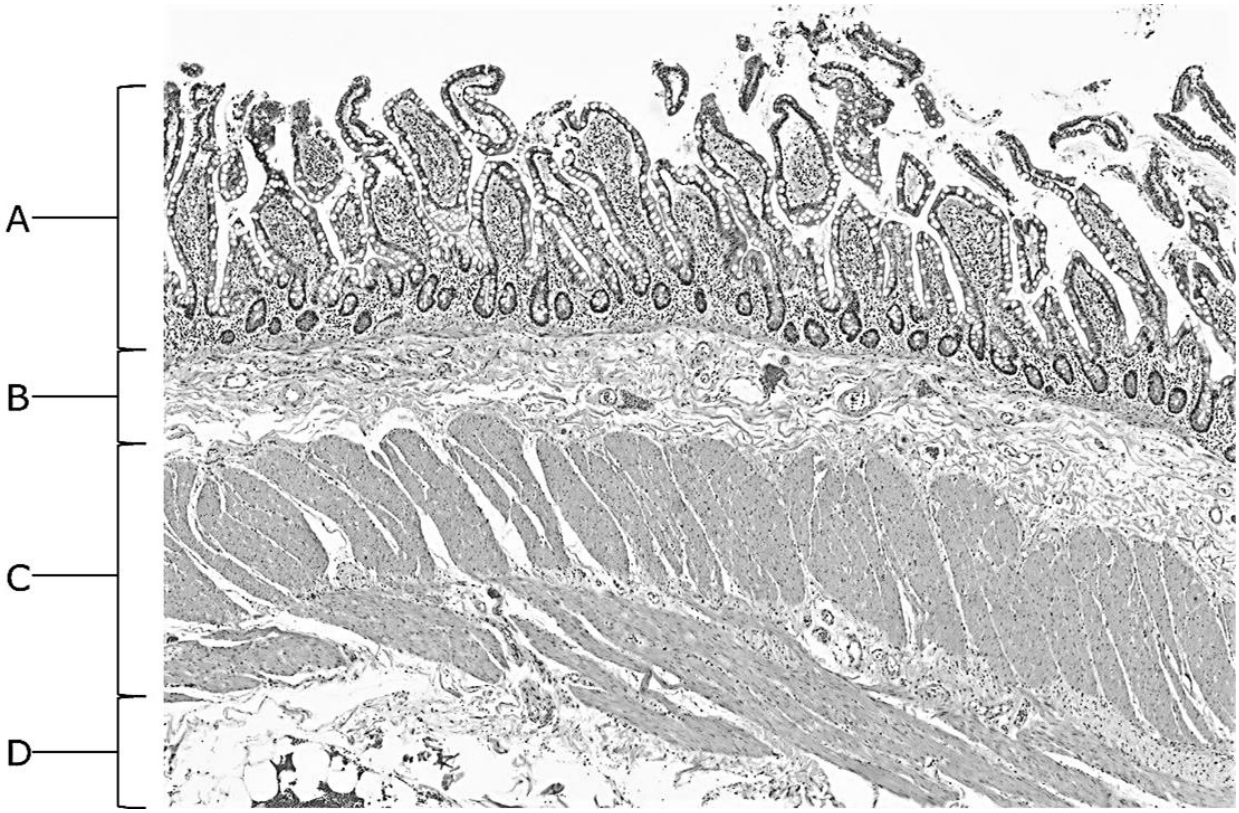

Figure 1: Histology of the ileum
(*Adapted from https://www.pathologyoutlines.com)*

Table 1: Layers of the ileum

Label	Layer
A	
B	
C	
D	

(2)

ii. Briefly explain how the structure and function of the layer labelled A differ between the ileum and the buccal cavity.

_____

_____

_____

_____ (2)

b. The digestive system regulates stomach conditions for efficient food breakdown. Key mechanisms include the control of gastrin secretion and the release of hydrochloric acid.

i. Explain the feedback mechanism that regulates gastrin secretion in the stomach.

_____

_____

_____

_____

_____

_____ (3)

ii. Briefly explain **THREE** functions of hydrochloric acid in the stomach.

_____

_____

_____

_____

_____ (3)

Question continues on the next page.

c. Complete Table 2 by identifying the source and the resulting product(s) produced by each digestive enzyme after acting on their respective substrates.

Table 2: Different digestive enzymes

Enzyme	Source of production	Product(s)
Salivary amylase		
Pepsin		
Lipase		
Carboxypeptidase		
Lactase		

(5)

d. Suggest why a person with a blocked bile duct has difficulty digesting fats.

_____

_____ (1)

(Total: 16 marks)

4. This question is about the nervous system.

a. Figure 2 shows the changes in membrane potential during an action potential.

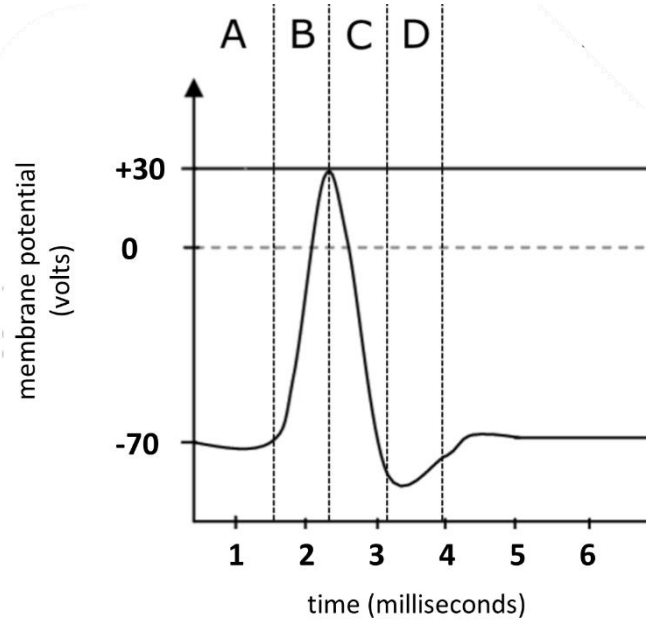

Figure 2: The course of an action potential
(Adapted from: https://www.researchgate.net)

Using the following terms (repolarisation, depolarisation, resting potential, hyperpolarisation), name the key events occurring at stages A to D of the action potential shown in Figure 2.

A. _____

B. _____

C. _____

D. _____ (2)

b. In 1949, Hodgkin and Katz conducted experiments on the squid giant axon to investigate how ion concentrations influence the action potential. Figure 3 shows membrane potentials recorded in seawater with different sodium ion concentrations.

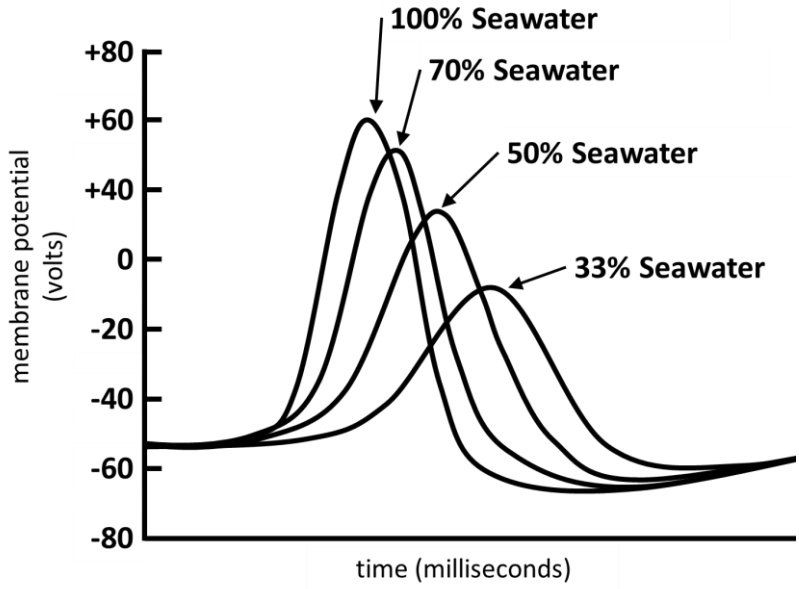

Figure 3: Membrane potentials recorded from squid axons bathed in seawater containing different concentrations of sodium ions
(Adapted from: https://www.sas.upenn.edu)

i. Explain why altering the sodium ion concentration in seawater affects the action potential.

_____

_____

_____

_____

_____

_____ (3)

Question continues on the next page.

ii. Squid axons are significantly larger in diameter than human axons. Suggest how a larger axon diameter benefits signal transmission.

_____

_____

_____ (2)

iii. Suggest how temperature might affect nerve impulse transmission in an ectothermic animal such as the squid compared to an endothermic animal such as a human.

_____

_____

_____

_____

_____ (3)

iv. Some neurological conditions lead to the loss of myelin in neurons. How does this loss affect nerve signal transmission?

_____

_____

_____ (2)

v. Does the intensity of a stimulus affect the magnitude of the action potential? Explain your answer.

_____

_____

_____ (2)

(Total: 14 marks)

5. The liver, together with other organs, plays an important role in regulating metabolism. Figure 4 shows a simplified overview of carbohydrate metabolism in the liver, illustrating conversions between glycogen, glucose and pyruvate.

Figure 4: The metabolic pathways that occur within the liver

a. Name the processes labelled A to D in Figure 4.

A. _____

B. _____

C. _____

D. _____ (2)

b. Identify the blood vessel(s) through which glucose is transported into the liver. Give a reason for your answer.

Transporting vessel(s): _____

Reason: _____

_____ (2)

c. For each scenario below, select the most appropriate process (from options A to D) as it occurs within the liver and justify your choice:

i. While preparing for a marathon, runners consume high-carbohydrate meals. Which process, B or C, is more relevant in this case? Give a reason for your answer.

Process: _____ Reason: _____

_____

_____ (2)

ii. During the first few metres of a marathon, which process, A or D, is more relevant? Give a reason for your answer.

Process: _____ Reason: _____

_____

_____ (2)

Question continues on the next page.

iii. During the last few metres of a marathon, after running continuously for 20 km, which process, B or D, is more relevant? Give a reason for your answer.

Process: _____ Reason: _____

_____

_____ (2)

d. Apart from carbohydrate metabolism, the liver performs several other vital functions. Describe **TWO** additional functions of the liver.

_____

_____

_____ (2)

(Total: 12 marks)

6. This question focuses on DNA organisation, the genetic code and mutations.

a. Explain what histones are and describe **ONE** of their functions.

_____

_____

_____ (2)

b. Chromosomes contain DNA, which encodes genes. Gene expression follows the genetic code. Below are two statements describing different characteristics of the genetic code. For each statement, identify the correct term that represents the mentioned characteristic.

i. Each nucleotide in a mRNA sequence belongs to only one codon.

Term: _____ (1)

ii. The genetic code is almost the same in most organisms. For example, the codon for tryptophan (UGG) codes for the same amino acid in both humans and bacteria.

Term: _____ (1)

c. The genetic code contains a start codon (AUG). Predict how a mutation in this codon would affect gene function.

_____

_____

_____ (2)

d. Explain how the redundancy of the genetic code protects organisms from the harmful effects of some mutations.

_____

_____

_____ (2)

e. DNA mutations can disrupt genetic information. Name the main enzyme that helps correct errors during DNA replication.

_____ (1)

f. Different types of point mutations affect gene sequences. Identify the type of point mutation in each of the following examples by completing Table 3.

Table 3: Types of mutation

Example	Original sequence	Mutated sequence	Type of mutation
Example 1	ATGCGTAAT	ATGACGTAAT	
Example 2	ATGCGTAAT	ATGAGTAAT	

(2)

g. One of the mutations in part (f) causes a frameshift. Identify the example and explain its possible impact on gene expression.

Example: _____

Explanation: _____

_____

_____ (2)

(Total: 13 marks)

7. This question concerns biotechnology.

a. EcoRI is an example of a restriction endonuclease.

i. Explain how a point mutation in the EcoRI recognition sequence (GAATTC) might affect EcoRI's function.

_____

_____

_____ (2)

Question continues on the next page.

ii. Describe **ONE** potential implication of having multiple EcoRI restriction sites in a plasmid when designing a recombinant DNA experiment.

_____

_____ (1)

iii. EcoRI creates sticky ends. How does this property improve the accuracy of DNA recombination?

_____

_____ (1)

b. Describe the role of DNA ligase in genetic engineering.

_____

_____

_____ (2)

c. A scientist needs to create thousands of copies of a gene for study through the use of PCR. List the main steps involved and the role of the key enzyme used in this technique.

_____

_____

_____

_____

_____

_____ (3)

d. Give **TWO** advantages of using genetically modified bacteria to produce human proteins like insulin or growth hormone.

_____

_____

_____ (2)

(Total: 11 marks)

8. This question is about environmental biology.

a. A temperate grassland ecosystem consists of multiple trophic levels, each supporting different organisms. Table 4 provides data on the number of individuals and their average biomass at each level.

Table 4: Organisms and biomass at each trophic level

Trophic level	**Number of individuals**	**Average biomass per individual (kg)**
Producers (grasses and shrubs)	10000	0.5
Primary Consumers (insects, rabbits and deer)	1000	2
Secondary Consumers (foxes, snakes and birds)	100	5
Tertiary Consumers (wolves and eagles)	10	10

i. Sketch a pyramid of numbers based on the data provided in Table 4. Clearly write the number of individuals for each trophic level.

(1)

ii. On the following page, sketch a pyramid of biomass using the data provided in Table 4. Show **all** calculations and clearly write the biomass present at each trophic level.

To estimate biomass at each trophic level:
biomass = number of individuals × average biomass per individual

_____

_____

_____

_____

Question continues on the next page.

(3)

iii. Sketch a pyramid of energy based on producers capturing 100000 kcal of energy. Assuming an energy transfer efficiency of 10%, calculate the available energy at each level. Clearly write the energy present at each trophic level.

(3)

b. In some ecosystems, the pyramid of numbers may be inverted, with a lower trophic level having fewer organisms than the level above it.

i. Provide an example of a food chain that leads to an inverted pyramid of numbers.

_____

_____ (1)

ii. Despite the inverted pyramid of numbers, the ecosystem still exhibits a pyramid of energy that is widest at the base and narrowest at the top. Explain why pyramids of energy are always like this regardless of the ecosystem.

_____

_____

_____

_____ (2)

c. The nitrogen cycle plays a crucial role in ecosystems.

i. Explain how nitrogen-fixing bacteria and decomposers contribute to nitrogen availability in ecosystems.

_____

_____

_____

_____

_____

_____ (3)

ii. Only a few organisms can fix nitrogen, yet nitrogen is essential for all living organisms. Mention **TWO** groups of biomolecules that contain nitrogen.

_____ (1)

(Total: 14 marks)

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE
EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2025 FIRST SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	II
DATE:	6th May 2025
TIME:	4:00 p.m. to 7:05 p.m.

Directions to Candidates

- Answer the question in Section A, any **TWO** questions from Section B and **ONE** question from Section C. Write all your answers in the separate booklet provided.
- If more than two questions from Section B are attempted, only the first two answers shall be taken into consideration.
- If more than one question from Section C is attempted, only the first answer shall be taken into consideration.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated.
- You are reminded of the necessity for good English and orderly presentation in your answers.
- In calculations you are advised to show all the steps in your working, giving your answer at each stage.
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SECTION A

1. Read the following extract carefully, and using the information provided and your knowledge of biology, answer the questions that follow. The numerals in the left-hand margin are the line numbers.

Forged by fire

A number of animals have adopted the strategy of darkening their colouration for camouflage in natural environments. Black colouration may be especially helpful for animals that live in unpredictable, wildfire-prone ecosystems such as savannahs, where lightning strikes and other phenomena lead to frequent fires. In these environments, the blackened background against which an animal must camouflage itself can change rapidly.

In such environments, a landscape that was once full of trees and vibrant colours may, in a matter of hours or days, become blackened, exposing animals that were previously concealed by their green or yellow-brown colouration. In rapidly reproducing species, such as insects and rodents, natural selection encourages the emergence of darker forms that provide effective camouflage against the black background.

Melanism, that is the occurrence of darker colouration due to an increase in the dark pigment melanin, occurs across a wide range of animals. Melanistic forms have been observed in insects, fish, amphibians, reptiles, birds and mammals. Sometimes these melanistic colour forms are adaptive, while at other times they occur randomly as anomalies. Adaptive melanism may not always relate solely to camouflage. For example, in one unusual case of industrial melanism, melanistic sea snakes in New Caledonia appear to concentrate pollutants in their skins, which are then shed.

Another study has suggested that a melanistic giant anteater (*Myrmecophaga tridactyla*) found in Brazil may have emerged as a result of wildfires. While the dark colouration could be adaptive in a blackened environment, population fragmentation and the resultant inbreeding may increase the frequency of the melanistic allele in the population. The same researchers described an albino anteater population from another wildfire-prone region in Brazil, indicating that such rare white forms may also develop in small, isolated populations.

Thus, Earth's darkest creatures are shaped by extreme environmental conditions and, some species are almost literally forged by fire. As Earth continues to warm and wildfires increase, it seems likely that these adaptations may emerge in an increasing number of animals in affected environments.

Adapted from: Pallardy (2024) What is 'fire melanism'? https://thebiologist.rsb.org.uk/biologist-features/forged-by-fire

a. How does the occurrence of wildfires impact the survival of animals with darker colouration in wildfire-prone ecosystems? (2)

b. In wildfire-prone areas, why are melanistic animal forms more likely to emerge in rapidly reproducing species such as insects and rodents (line 8)? (2)

c. Suggest why species living in wildfire-prone areas are more susceptible to habitat fragmentation and inbreeding (line 20). (2)

d. Discuss **ONE** negative genetic consequence of inbreeding. (2)

e. Using the example of the giant anteater (line 18), explain how habitat fragmentation and inbreeding, together with repeated wildfires, may have increased the frequency of melanistic alleles. (3)

f. The extract mentions an albino (light-coloured) anteater population (line 21-22) from a wildfire-prone region. Given that this colouration does not aid in camouflage, suggest what could have led to the emergence of a population with this colour. (2)

g. Explain how geographical isolation, resulting from wildfire-caused fragmentation, can lead to speciation. (2)

h. Speciation can occur without physical barriers. Name this type of speciation. (1)

i. Suggest **TWO** consequences of frequent wildfires on ecological succession. (3)

j. How do wildfires contribute to the carbon cycle and what is the impact of increased wildfire frequency on the concentration of greenhouse gases in the atmosphere? (2)

k. What advantage might melanistic sea snakes in New Caledonia (line 16) gain by concentrating pollutants in their skin? (2)

l. The extract discusses adaptations to pollutants and wildfire. List **TWO** other human-induced threats that can drive evolutionary adaptations in animals. (2)

(Total: 25 marks)

SECTION B
Answer any TWO questions from this section; your answers should take the form of essays. Each question carries twenty-five marks.

1. Compare and contrast the structures of a generalised plant cell and a generalised animal cell, focusing on the functions of their organelles.

2. Discuss how density-dependent and density-independent factors regulate population growth and size.

3. Provide an overview of the innate immune system, explaining how the first and second lines of defence protect the body from infection.

4. The evolution of mass flow systems became necessary as internal distances in the bodies of animals increased. Discuss this statement with reference to insects, fish and mammals.

(Total: 50 marks)

SECTION C
Answer ONE question from this section.

1. Use your knowledge of biology to explain the following statements:

   a. Antagonistic muscles allow for movement in earthworms. (5)

   b. The exoskeleton is essential for locomotion in arthropods. (5)

   c. Muscular contraction in mammals relies on tendons to generate locomotion. (5)

   d. In mammals, oxygen-lacking conditions will lead to the inability of muscles to contract effectively. (5)

   e. The mammalian skeletal system is composed of both spongy and compact bone. (5)

(Total: 25 marks)

OR

2. Use your knowledge of biology to explain the following statements related to human biology:

   a. Meiosis leads to genetic diversity. (5)

   b. Mutations during gamete formation can still result in viable sperm and egg cells. (5)

   c. FSH and LH are needed for gametogenesis to occur in both males and females. (5)

   d. hCG is the hormone used to confirm pregnancy, not progesterone. (5)

   e. Mitochondrial DNA can determine maternal lineage but not paternal ones. (5)

(Total: 25 marks)

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MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2025 FIRST SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	III
DATE:	7th May 2025
TIME:	9:00 a.m. to 10:35 a.m.

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions. Write all your answers in the spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated.
- You are reminded of the necessity for good English and orderly presentation in your answers.
- In calculations you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.

For examiners' use only:

Question	1	2	3	**Total**
Score				
Maximum	11	20	19	**50**

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1. This question is about plant diversity.

a. Figure 1 to Figure 4 show images of plant species.

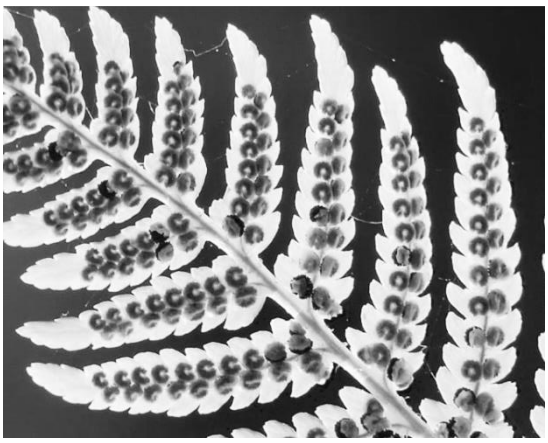

Figure 1
(Source: https://www.epicgardening.com)

Figure 2
(Source: https://warehouse1.indicia.org.uk)

Figure 3
(Source: https://www.croftseeds.co.uk)

Figure 4
(Source: https://i0.wp.com)

Identify a major taxonomic group within the Plant kingdom in which each of the four plants shown in Figures 1 to 4 may be classified. Also, for each one, indicate whether the plant is characterised by a dominant gametophyte or sporophyte.

	Major taxonomic group	**Species characterised by a dominant gametophyte or dominant sporophyte**
Figure 1		
Figure 2		
Figure 3		
Figure 4		

(6)

b. This question is about the Brassicaceae flower.

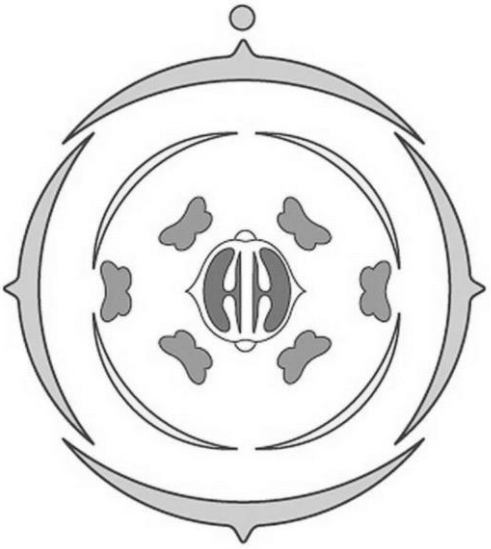

Figure 5: Image on the left represents a Brassicaceae flower, while the diagram on the right shows the floral diagram to this flower.
(Source: https://newfs.s3.amazonaws.com and https://microbenotes.com)

i. Does this flower belong to a monoecious or a dioecious plant? Explain your answer.

_____

_____ (1)

ii. Is the flower in Figure 5 zygomorphic or actinomorphic? Explain your answer.

_____

_____ (1)

iii. Based on the information in Figure 5, suggest whether it is more likely for this plant to be a monocot or a dicot? Explain your answer.

_____

_____ (1)

iv. Based only on the information in the floral diagram (Figure 5), write the floral formula for the flower.

_____ (2)

(Total: 11 marks)

2. This question is about leaf modifications and water transport in plants.

a. The image in Figure 6 shows a transverse section of a *Nymphaea* leaf.

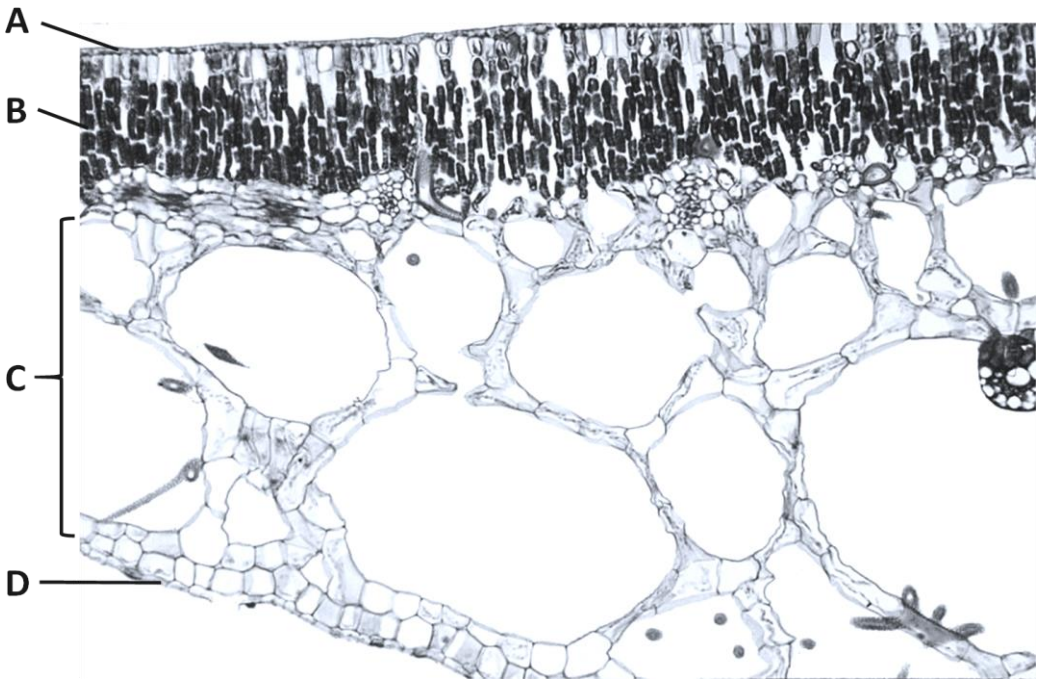

Figure 6: A transverse section from *Nymphaea* leaf as seen under a light microscope.
(Adapted from: https://propg.ifas.ufl.edu)

i. Identify the cells or structures labelled A to D.

Label	Cells or structures
A	
B	
C	
D	

(2)

ii. Explain **TWO** leaf adaptations that enable *Nymphaea* to thrive in an aquatic habitat.

Adaptation 1: _____

_____

_____

Adaptation 2: _____

_____

_____ (3)

b. The image in Figure 7 shows a transverse section from a Marram grass leaf.

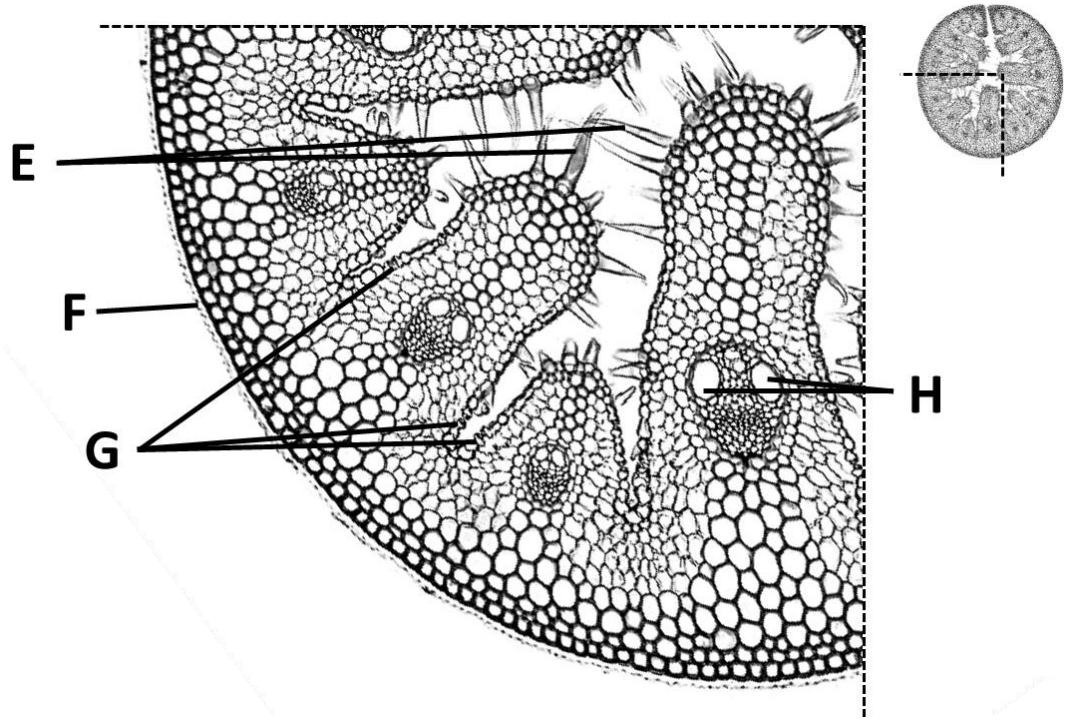

Figure 7: Part of a transverse section from Marram grass leaf as seen under a light microscope.
(Adapted from: https://www.science-photo.de)

i. Identify the cells or structures labelled E to H.

Label	Cells or structures
E	
F	
G	
H	

(2)

ii. Explain the role of the cells or structures labelled E, F and G in enabling Marram grass survive in xeric conditions.

Label E: _____

_____ (1)

Label F: _____

_____ (1)

Label G: _____

_____ (1)

Question continues on the next page.

iii. Describe another leaf adaptation (not mentioned in part ii) that enables Marram grass to thrive in xeric conditions.

_____

_____

_____ (2)

c. An experiment was conducted to investigate the relationship between the cuticle permeability and the rate of transpiration in different plants species. The results of this experiment are summarised in Table 1 below.

Table 1: The effect of cuticle permeability on the rate of transpiration.

Plant Species	**Cuticle Permeability**	**Rate of transpiration (mg cm^{-2} h^{-1})**
Cactus	Low	0.21
Tomato	Moderate	1.10
Rose	Moderate	1.35
Lettuce	High	1.90

i. List and justify **TWO** conditions that should be kept constant during this experiment when measuring the rate of transpiration for the different plants.

_____

_____

_____

_____ (3)

ii. Suggest **ONE** factor that could cause a difference in cuticle permeability.

_____ (1)

iii. Using the results provided in Table 1, what conclusion can be drawn about the effect of cuticle permeability on the rate of transpiration?

_____

_____ (1)

iv. Explain why the relationship between cuticle permeability and rate of transpiration is important for cacti to live in their natural habitat.

_____

_____ (1)

v. Suggest and explain **ONE** possible reason why the tomato and rose plants, despite having similar cuticle permeability, show slight differences in transpiration rates.

_____

_____ (2)

(Total: 20 marks)

3. This question is about dihybrid inheritance in rabbit.

a. Two wild rabbits, both heterozygous for fur colour and ear size, were captured for a breeding programme. The Punnett square in Table 2 shows a dihybrid cross between these two individuals, focusing on two genetic traits, fur colour (D or d) and ear size (E or e), assuming that the two traits are coded by genes that assort independently during meiosis.

Table 2: A Punnett square showing a dihybrid cross between two wild rabbits.

		Male			
		DE	**De**	**dE**	**de**
Female	**DE**	DDEE	DDEe	DdEE	DdEe
	De	DDEe	DDee	DdEe	Ddee
	dE	DdEE	DdEe	ddEE	ddEe
	de	DdEe	Ddee	ddEe	ddee

i. Using the data provided in the Punnett square, give the genotype of the two individuals used in this cross.

Male: _____ Female: _____ (1)

Question continues on the next page.

ii. Using the information in Table 2, what is the simplest ratio for the four expected phenotypes? Insert the values in the space below, the last value is provided.

Dark fur and short ears	:	Dark fur and long ears	:	Light fur and short ears	:	Light fur and long ears
_____	:	_____	:	_____	:	1

(1)

iii. Given that there were 80 offspring in this cross, use the ratio identified in part (ii) to calculate the expected number of offspring for each phenotype. Show your working and insert the expected values in the space below.

_____

_____

_____

Dark fur and short ears	:	Dark fur and long ears	:	Light fur and short ears	:	Light fur and long ears
_____	:	_____	:	_____	:	_____

(2)

During the breeding programme, the observed number of offspring per phenotype was recorded below.

Dark fur and short ears	:	Dark fur and long ears	:	Light fur and short ears	:	Light fur and long ears
48	:	9	:	16	:	7

These observed numbers differ from the expected numbers calculated in part (iii), raising uncertainty on whether the two genetic traits under study assort independently or not.

Answer the following questions by using a chi-squared test (X^2) to determine whether the difference between the observed and expected ratios is statistically significant or simply due to chance.
The equation for this test is given below:

$$X^2 = \sum \frac{(\text{Observed value} - \text{Expected value})^2}{\text{Expected value}}$$

Note: The symbol ∑ means 'sum of'. Therefore, calculate $\frac{(\text{Observed value} - \text{Expected value})^2}{\text{Expected value}}$ for each phenotype and then add the results to find the chi-squared value.

iv. Provide a suitable null hypothesis for this test.

_____

_____ (1)

v. Using the observed and expected numbers for each phenotype category, calculate the chi-squared value for this data set. Show your working below.

_____

_____

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_____

_____ (5)

vi. How many degrees of freedom are associated with this chi-squared test?

_____ (1)

vii. A chi-squared distribution table shows that the critical value for X^2 at a significance level of P = 0.05 is 7.82. Based on this, explain whether the two studied traits are likely to be coded by genes on the same chromosome or on different chromosomes.

_____

_____

_____

_____ (3)

b. Scientists noted that wild rabbit populations are declining due to predators, hunting and habitat loss. They believe that rabbits with dark fur and long ears have a higher chance of survival.

i. Suggest why longer ears might increase the chances of survival in relation to current threats.

_____

_____ (1)

ii. In a separate breeding programme, the scientists were only able to capture a **male with light fur and short ears,** and a **female with dark fur and short ears.** In this case, would it still be genetically possible to produce F_1 offspring with the dark fur and long ears phenotype? Justify your answer.

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_____

_____ (4)

(Total: 19 marks)

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L-Università ta' Malta

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD

ADVANCED MATRICULATION LEVEL
2025 FIRST SESSION

SUBJECT:	**Biology**
PAPER NUMBER:	IV – *Practical*
DATE:	5th June 2025
TIME:	1 hour 35 minutes

Directions to Candidates

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** parts of the question. Write all your answers in this booklet. Drawings of biological material and graphical representations of data are to be made on the appropriate pages within this booklet.
- The marks allotted to parts of question are indicated.
- You are reminded of the necessity for good English and orderly presentation in your answers.
- In calculations you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.

For examiners' use only:

Question	**Total**
Score	
Maximum	**40**

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1. During fermentation, yeast metabolises sugars, producing a gas which, when in solution, rises to the surface and forms foam. The foam indicates fermentation and its volume can be used to estimate the rate of fermentation.

   The rate of fermentation is dependent on the source of sugar available. You are required to devise and implement an experimental procedure to investigate the effect of different disaccharides on the rate of fermentation in yeast.

   You are provided with the following:
   - 0.05 mol dm^{-3} sucrose solution;
   - 0.05 mol dm^{-3} maltose solution;
   - 0.05 mol dm^{-3} lactose solution;
   - distilled water;
   - yeast powder;
   - a small spoon;
   - small cups which may be used to transfer solutions;
   - syringes to measure volumes;
   - other laboratory apparatus as required.

a. Explain what the presence of foam indicates about the metabolic activity during fermentation.

_____

_____ (1)

b. Explain why the disaccharides provided are of the same concentration.

_____

_____ (1)

c. Yeast must hydrolyse disaccharides into monosaccharides before the sugars can be used for fermentation. Explain why different enzymes are required to hydrolyse the different disaccharides provided.

_____

_____

_____

_____ (2)

d. Using the materials provided, devise and describe an experimental procedure, including a suitable control, to investigate the effect of the different sugars on the rate of fermentation.

It is recommended that for each test you:

- use 5 mL of sugar solution;
- use the sugar solutions in the concentration given;
- gently transfer a levelled teaspoon of yeast powder into the test tube (teaspoon may be levelled using a ruler);
- stop the experiment after a maximum of 20 minutes (or earlier as required).

While it is advisable to mix the sugar solution and yeast when setting up the experiment, it is recommended not to mix further once the experiment is running.

Question continues on the next page.

_____

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_____ (10)

e. Justify **TWO** precautions that should be taken during the experiment.

Precaution 1: _____

_____

_____

_____ (2)

Precaution 2: _____

_____

_____

_____ (2)

Carry out the investigation that you devised in part (d) and record your results in part (f).

f. Record your results in the space below. *Marks will be awarded for the structure and the organisation of the results obtained.*

(6)

g. Draw a graph to represent your results on the graph paper provided on the following page.

(6)

Question continues on the next page.

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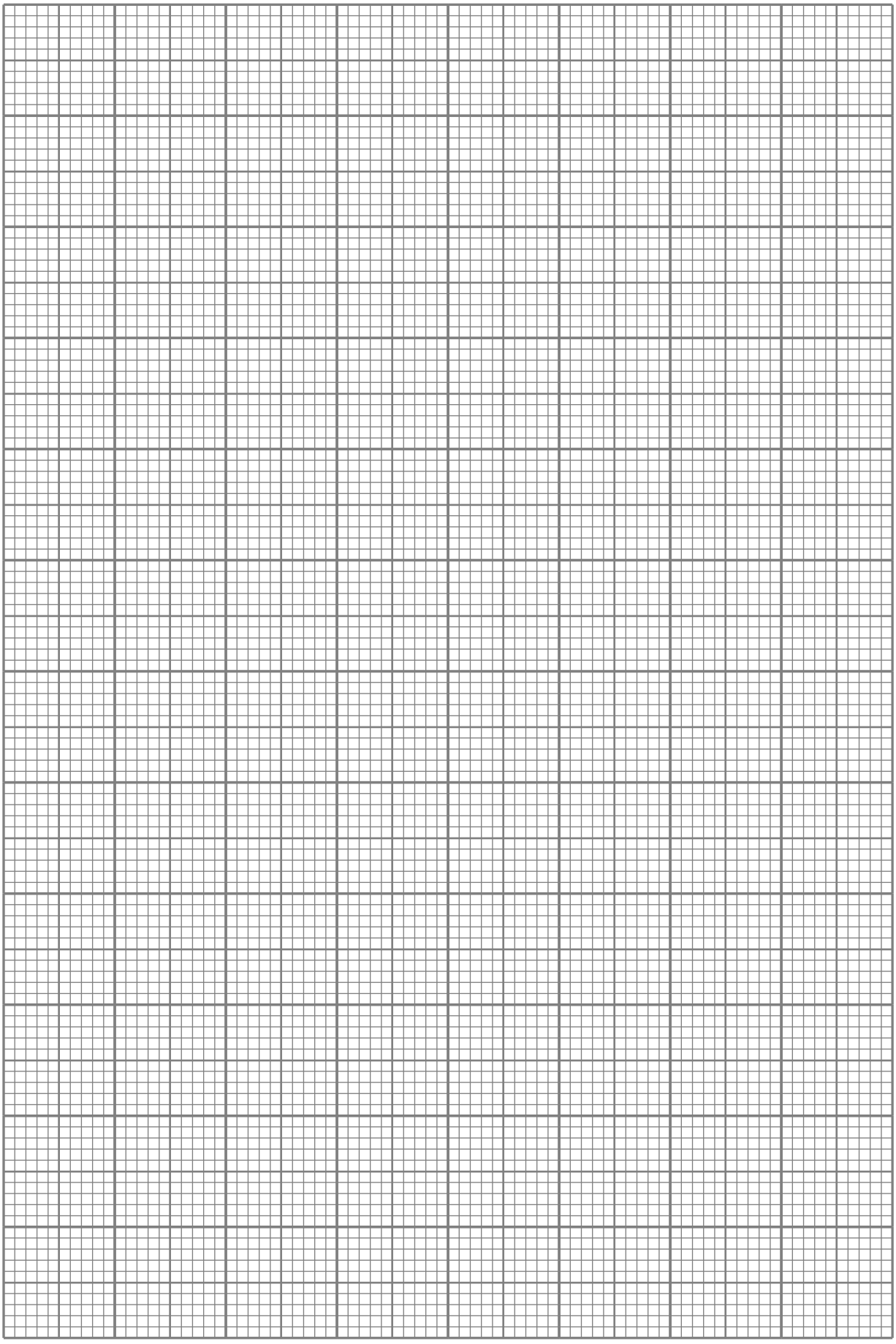

h. Describe the observed effect of each disaccharide on the rate of fermentation in yeast.

_____

_____

_____

_____ (2)

i. Interpret your results in terms of the activity of the enzymes involved in the hydrolysis of disaccharides.

_____

_____

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_____

_____ (4)

j. Given that sucrose is broken down into monosaccharides outside the cell, while maltose is broken down into monosaccharides within the cell, discuss the possible implications this may have on the rate of fermentation as observed during the experiment.

_____

_____

_____

_____ (2)

k. List **TWO** sources of error that may have occurred during your investigation.

Source of error 1: _____

_____

Source of error 2: _____

_____ (2)

(Total: 40 marks)

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