AM 05/III.16m

DO NOT WRITE ABOVE THIS LINE
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1. This question is about ecology.

1.1 A study was carried out to determine the population size of the endemic Balearic lizard *Podarcis lilfordi*, in three islets in the south coast of Mallorca (Spain); Es Caragol, Na Guardia and Na Moltona. Given the geographical features of the area of study, lizard populations of these islets could be considered as three separate closed populations. In this regard, the **capture-recapture method** was considered suitable for the purpose of this study.

1.1.i. Briefly describe the technique which is used to capture and mark the organism in question.

Examples of capturing techniques:	pit-falls traps / netting *(other suitable techniques possible)*	1 mark
Examples of marking:	paint / dye / marker / ring / tagging *(other suitable techniques possible)*	1 mark

[two marks]

1.1.ii. List **TWO** precautions that should be taken during marking, to make sure that it does not interfere with the study.

*Accept **any two** of the following*	1 mark each - MAX 2 marks
Marking does not hinder the movement of the organism	
Marking does not make the organism conspicuous to predators	
Marking does not cause any damage to the organism	
That the mark is permanent or difficult to remove	

[two marks]

1.1.iii. **Table 1** shows the data collected from the three islets during the study.

Table 1: Capture – Recapture Method Results

	Es Caragol	Na Guardia	Na Moltona
First sampling session			
Number of lizards captured	170	315	400
Second sampling session			
Total number of lizards recaptured	140	295	450
Number of marked lizards	34	35	25
Area (hectares)	0.29	1.98	5.09

Estimate the size of each islet population, using the Lincoln Index:

$$N = \frac{n_1 \times n_2}{m}$$

where:
N = estimated population size
n_1 = number of individuals captured during the first sampling session
n_2 = number of individuals recaptured during the second sampling session
m = number of marked individuals in recaptured.

Show your working.

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Es Caragol	N= (170*140)/34	0.5 mark
	700	0.5 mark
Na Guardia	N = (315*295)/35	0.5 mark
	2655	0.5 mark
Na Moltona	N = (400*450)/25	0.5 mark
	7200	0.5 mark

[three marks]

1.1.iv. Which islet has the highest population density of *Podarcis lilfordi*? Explain your answer.

Population density = population size divided by area of islet		1 mark
Es Caragol	700/0.29 = 2414 individuals/ha	0.5 mark
Na Guardia	2655/1.98 = 1341 individuals/ha	0.5 mark
Na Moltona	7200/5.09 = 1415 individuals/ha	0.5 mark
Therefore highest population density: Es Caragol		0.5 mark

[three marks]

1.1.v. Why could the islets be assumed to be closed populations for the purpose of this study?

In the case of this study, movement of organisms is restricted geographically since the study area consists of three small islands.	1 mark
This ensures that no other factors like immigration or emigration interfere with the outcome of the study.	1 mark

[two marks]

1.1.vi. To increase the viability of this method, the time lapse between the first capture and the recapture must be very small compared to the life span of the organism being sampled. Explain.

This ensures that changes in population sizes as a result of births and deaths are negligible.	1 mark

[one mark]

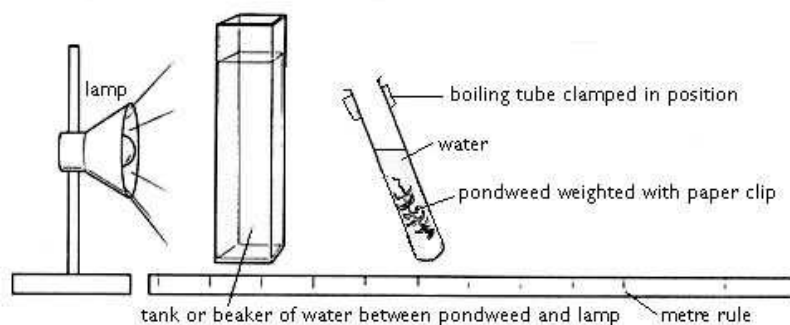1.1.vii. List **THREE** limitations of the capture-recapture technique.

Accept *any three* of the following:	
Individuals might not be randomly distributed throughout the whole study area and therefore some may be more easily captured than others	
Marked animals may become wary of traps (i.e. would affect probability of recapture)	
The animal needs to be captured to be marked and this may alter its behaviour pattern (or injure it)	1 mark each – MAX 3 marks
Part of the geographical region may be less accessible for sampling	
Mark might wear off.	
Lizards might be weakened due to lack of food when captured and therefore it becomes easier to capture them again.	
Applies only to closed systems	
Traps not very specific - other animals might be trapped.	
The inability to sample of the population....you only get estimates.	
Realistically immigration and emigration occur.	

[three marks]
[Total: Sixteen marks]

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2.   This question is about photosynthesis

2.1   In an experiment to determine the effect of light intensity on the rate of photosynthesis, the apparatus depicted in **Figure 1** was set up. The rate of photosynthesis was estimated using the number of bubbles produced by the pondweed per minute. Light intensity was measured as the inverse of the distance of the pondweed from the lamp.

Figure 1: Experiment determining how light intensity affects the photosynthetic rate.

(Source: http://www.nuffieldfoundation.org/practical-biology/investigating-factors-affecting-rate-photosynthesis)

2.1.i.   Give **TWO** assumptions that are being made in this experiment.

*Accept **any two** of the following*	1 mark each – MAX 2 marks
The gas bubbles being counted are only oxygen,	
The production of oxygen is proportional to the rate of photosynthesis.	
All the bubbles are the same size	
The light intensity is inversely proportional to the distance	

[two marks]

2.1.ii.   Name **TWO** limiting factors apart from light intensity that might affect this experiment.

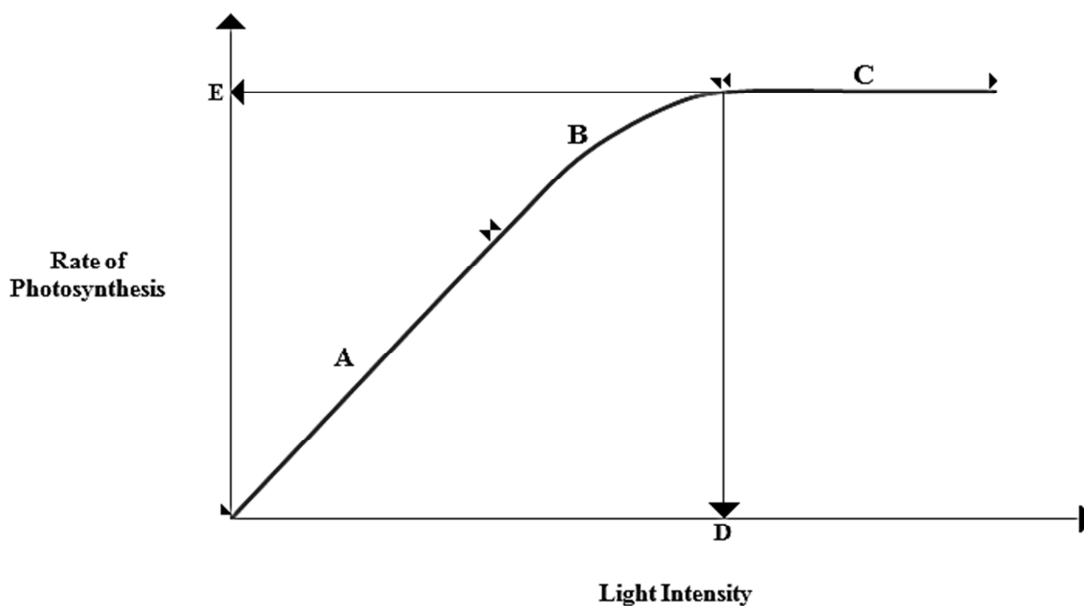| Carbon dioxide	1 mark
Temperature	1 mark

[two marks]

2.1.iii. What is the function of the tank of water which is the placed between the pondweed and the lamp?

*Accept **ONE** of the following:*	
To absorb the heat from the lamp	1 mark
Thermal buffer	

[one mark]

Typical results of this experiment are shown in **Figure 2**.

Figure 2: Effect of light intensity on the rate of photosynthesis

2.1.iv. Briefly discuss whether light intensity is the major limiting factor in regions A, B and C of the curve.

A	Light is the limiting factor	1 mark	
B	Some factor other than light intensity is becoming limiting (both light and this other factor are limiting)	1 mark	_Reject if **only** light intensity is mentioned_
C	Light intensity is no longer limiting	1 mark	

[three marks]

2.1.v. What do points D and E represent?

| D | Saturation point for light intensity (no further increase in light intensity will cause any further increase in the rate of photosynthesis) | 1 mark |
| E | Maximum rate of photosynthesis attainable | 1 mark |

[two marks]

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2.2   An experiment was carried out to study the exchange of carbon dioxide between the atmosphere and two plant species (species I and species II) over a range of light intensities. The temperature was kept constant throughout the course of the experiment, and the net carbon dioxide absorption by each plant species was recorded and tabulated in **Table 2** below.

Table 2: Net Absorption of Carbon Dioxide during Photosynthesis

Light intensity (%)	Net carbon dioxide absorption in arbitrary units	
	Species I	**Species II**
0	-0.9	-0.2
10	-0.8	-0.1
20	-0.6	+1.2
30	-0.4	+3.0
40	+1.4	+5.5
50	+2.6	+6.1
60	+4.8	+6.2
70	+5.7	+6.3
80	+6.9	+6.3
90	+7.7	+6.3
100	+8.5	+6.3

2.2.i.   Using the same scale and axes, plot graphs of net carbon dioxide absorption with light intensity for both plant species I and II. Use the graph paper provided.

[five marks]

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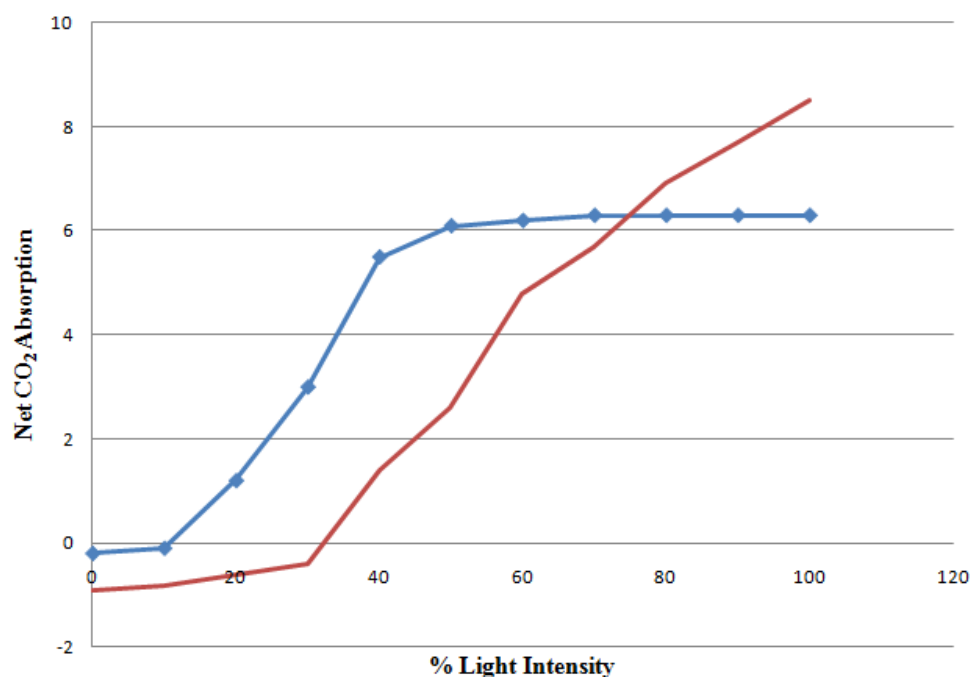
Correct axes (i.e. net CO_2 absorption on y-axis and % light intensity on x-axis)	1 mark
axes titles (y= net CO_2 absorption; x=% light intensity)	1 mark
correct plotting (including scale) for plant species I	1 mark
correct plotting (including scale) for plant species II	1 mark
graph title 'A Graph showing net CO_2 absorption by plant species I and II over a range of % light intensities'	0.5 mark
KEY (Plant Species I and Plant Species II)	0.5 mark

2.2.ii. Explain what is happening in the two plant species when the light intensity is between 70 and 80%.

| Species II rate of photosynthesis reached saturation point	1 mark
Species I still increasing the rate	1 mark

[two marks]

2.2.iii. Use the graph to determine the light intensities at which plant species I and II reach compensation point.

Species I	≈ 31-32%	1 mark
Species II	≈ 11%	1 mark

[two marks]

[Total: Nineteen marks]

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3.   This question is about flowering plants.

3.1   This is the floral formula for a flower belonging to the family Solanaceae.

$$\oplus \, \male\!\female \, K_{(5)} \; \overset{\frown}{C}_{(5)} \; A_{(5)} \; \underline{G}_{(2)}$$
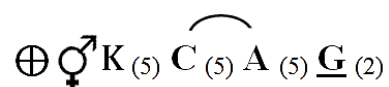
Candidates are to note that K is sometimes substituted by Ca and C by Co.

3.1.i. Use the information provided in this floral formula to construct the floral diagram of this flower.

Floral diagram

Sepals -5	0.5 mark
Sepals - fused	0.5 mark
Petals - 5	0.5 mark
Petals - fused	0.5 mark
Stamens -5	0.5 mark
Stamens fused to petals	1 mark
Gynaecium -1	0.5 mark
2 carpels	0.5 mark
Fused stamens	0.5 mark

[five marks]

3.1.ii. What is the sexuality of this flower?

hermaphrodite / monoecious	1 mark	*Reject bears both male and female organs – term is expected at this level*

[one mark]

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3.1.iii.   What does the floral formula infer about the composition and position of the gynaecium?

Bicarpellary / two fused carpels	1 mark
Superior to all other floral parts	1 mark

[two marks]
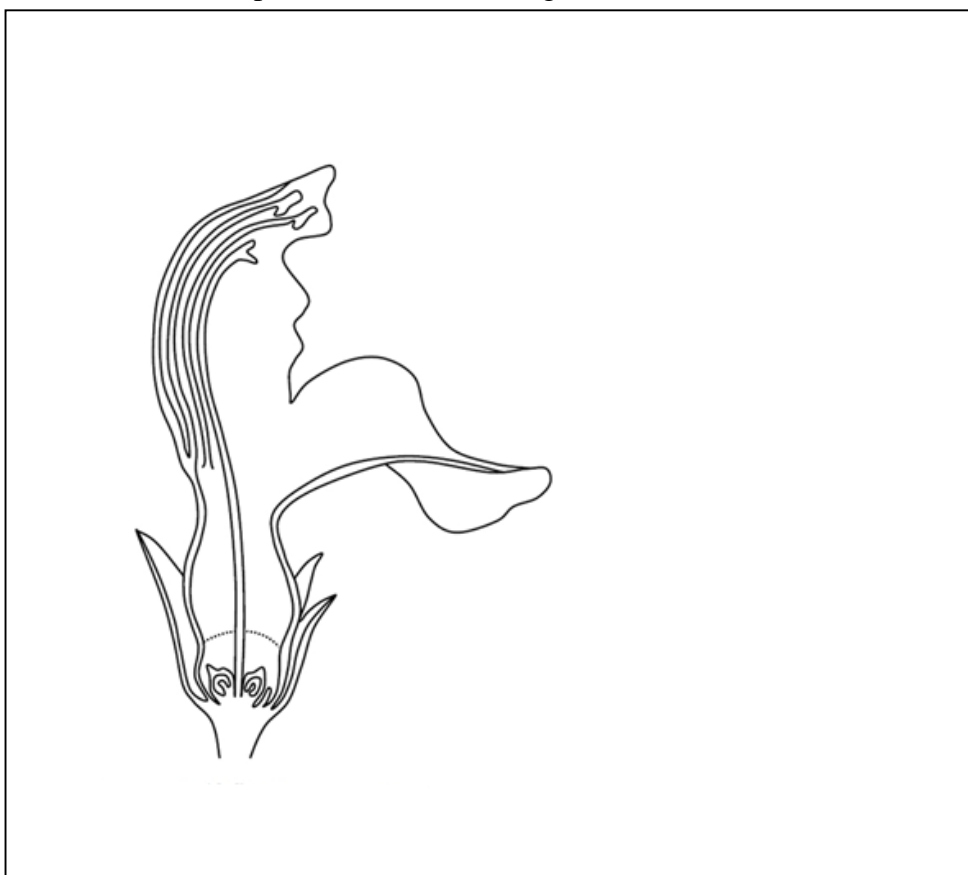
3.1.iv.   What is the biological term for the type of symmetry that this flower exhibits?

actinomorphic	1 mark

[one mark]

3.2   **Figure 3** shows the half-flower diagram of White Deadnettle (*Lamium album*).

3.2.i.   Label the flower parts shown in this diagram.

Figure 3: Half-flower Diagram of *Lamium album*

Stigma	0.5 mark	
Style	0.5 mark	
Ovary	0.5 mark	
Receptacle	0.5 mark	
Pedicle	0.5 mark	
Sepal	0.5 mark	
Petal	0.5 mark	
Stamens (or both anther and filament)	0.5 mark	*Reject if ONLY anther OR filament is labelled*

[four marks]

3.2.ii. *Lamium album* is an entomophilous flower. Give TWO characteristic visible in **Figure 3** that is associated with this kind of pollination.

Accept ANY of the following:	
Large petals	
Presence of nectary	2 marks
Small stigma enclosed within flower	
Stamens enclosed within flower	
Zygomorphic	

[two marks]

[Total: Fifteen marks]