AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

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Forename(s) _____

Candidate signature _____

I declare this is my own work.

A-level BIOLOGY

Paper 2

Time allowed: 2 hours

Materials

For this paper you must have:
- a ruler with millimetre measurements
- a scientific calculator.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 91.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

Answer **all** questions in the spaces provided.

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0 1 . 1 Describe the process of glycolysis.

[4 marks]

0 1 . 2 Malonate inhibits a reaction in the Krebs cycle.

Explain why malonate would decrease the uptake of oxygen in a respiring cell.

[2 marks]

6

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0 2 . 1 Explain how a resting potential is maintained across the axon membrane in a neurone.

[3 marks]

0 2 . 2 Explain why the speed of transmission of impulses is faster along a myelinated axon than along a non-myelinated axon.

[3 marks]

Question 2 continues on the next page

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0 2 . 3 A scientist investigated the effect of inhibitors on neurones. She added a respiratory inhibitor to a neurone. The resting potential of the neurone changed from –70 mV to 0 mV.

Explain why.

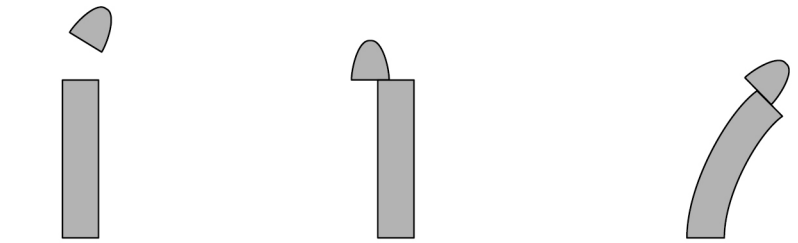
[3 marks]

9

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0 3 **Figure 1** shows an investigation into growth factors in plants.

Figure 1



Tip removed from shoot of plant

Then, tip replaced on one side of cut shoot

Then, growth curvature occurred **without** a directional light source

0 3 . 1 Use your knowledge of indoleacetic acid (IAA) to explain the growth curvature shown in **Figure 1**.

[3 marks]

Question 3 continues on the next page

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A bioassay is a method to determine the concentration of a substance by its effect on living tissues.

Figure 2 shows the practical procedure used in a growth curvature bioassay to determine the concentration of IAA in shoot tips.

Figure 2

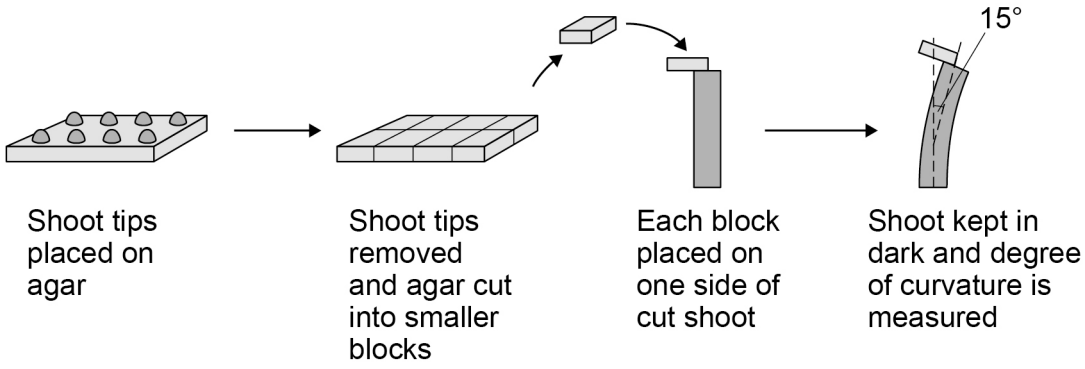
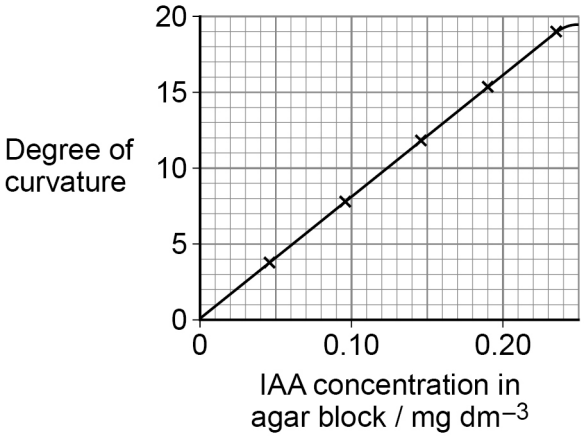


Figure 3 shows the calibration curve for this growth curvature bioassay.

Figure 3



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0 3 . 2 Using the procedure in **Figure 2** and the calibration curve in **Figure 3**, describe how you could compare the IAA concentration in shoot tips from two different plant species.

In your answer you should refer to all the variables that should be controlled to produce a valid comparison.

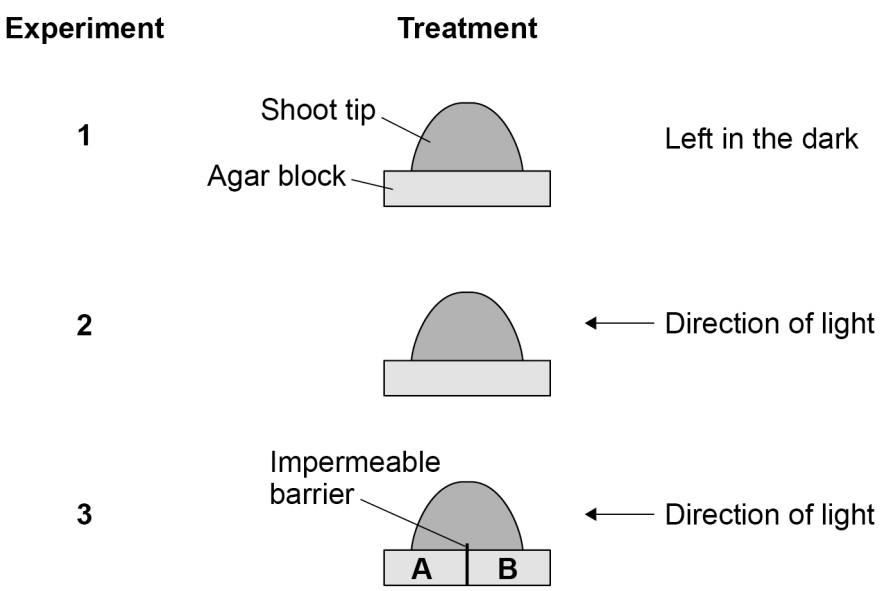
[5 marks]

Question 3 continues on the next page

Do not write outside the box

A scientist investigated the effect of a directional light stimulus on the distribution of IAA in shoot tips. The scientist set up three experiments as shown in **Figure 4**. All variables were controlled apart from exposure to light.

Figure 4



She then used the growth curvature bioassay to compare the IAA concentrations in the agar blocks from:

- experiment **1**
- experiment **2**
- experiment **3** section **A**
- experiment **3** section **B**.

Table 1 shows the scientist's results.

Table 1

Experiment	Degree of curvature in Bioassay / degrees
1	17.69
2	17.61
3A	11.22
3B	6.50

Do not write outside the box

0 3 . 3 State **two** conclusions about IAA that you can make from the results shown in **Table 1**.

[2 marks]

1 _____

_____

2 _____

_____

10

Turn over for the next question

Do not write outside the box

0 4 In fruit flies, males have the sex chromosomes XY and the females have XX.
In fruit flies, a gene for eye colour is carried on the X chromosome. The allele for red eyes, **R**, is dominant to the allele for white eyes, **r**.

0 4 . 1 Male fruit flies are more likely than female fruit flies to have white eyes.

Explain why.

[2 marks]

0 4 . 2 A female fruit fly with white eyes was crossed with a male fruit fly with red eyes to produce a large number of offspring.

Tick (✓) **one** box next to the statement which correctly describes the phenotypes produced from this cross.

[1 mark]

All offspring red-eyed ☐

All females red-eyed, all males white-eyed ☐

All males red-eyed, all females white-eyed ☐

All males white-eyed, females red-eyed and females white-eyed ☐

Do not write outside the box

In fruit flies, the genes for body colour and for wing development are **not** on the sex chromosomes. The allele for grey body colour, **G**, is dominant to the allele for black body colour, **g**. The allele for long wings, **L**, is dominant to the allele for short wings, **l**.

A geneticist carried out a cross between fruit flies with grey bodies and long wings (heterozygous for both genes) and fruit flies with black bodies and short wings.

Table 2 shows the results of this cross.

Table 2

Phenotype of offspring	Number of offspring
Grey body **and** long wings	223
Black body **and** short wings	218

0 4 . 3 Explain the results in **Table 2**.

[3 marks]

Question 4 continues on the next page

Turn over ►

Do not write outside the box

0 4 . 4 The **first** generation of a population of fruit flies had 50 females.

Calculate how many female fruit flies would be produced from this population in the **fifth** generation.

You can assume:

- each female produces 400 offspring each generation
- half the offspring produced each generation are female
- there is no immigration or emigration
- no flies die before reproducing.

Show your working.

Give your answer in standard form.

[3 marks]

Answer _____

9

Do not write outside the box

0 5 . 1 Neonatal diabetes is a disease that affects newly born children. The disease is caused by a change in the amino acid sequence of insulin.

This change prevents insulin binding to its receptor. Explain why this change prevents insulin binding to its receptor.

[2 marks]

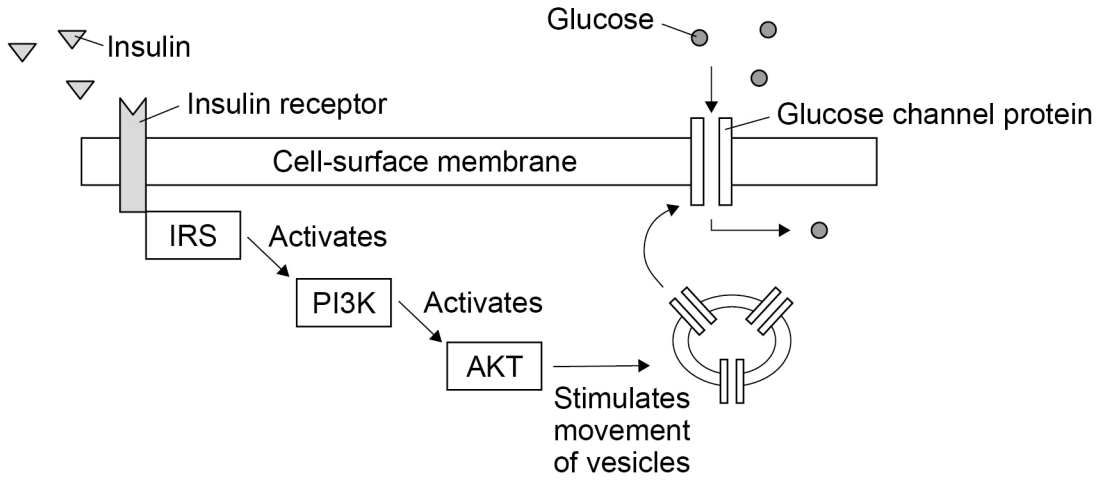
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Phosphoinositide 3-kinase (PI3K) is an enzyme in several metabolic processes.

Figure 5 shows the role of PI3K in the control of blood glucose concentration.

Figure 5



0 5 . 2 A decrease in the activity of PI3K can cause type II diabetes.

Use **Figure 5** to explain why.

[3 marks]

Do not write outside the box

0 5 . 3 Using your knowledge of the kidney, explain why glucose is found in the urine of a person with untreated diabetes.

[3 marks]

8

Turn over for the next question

Do not write outside the box

0 6 Myelodysplastic syndromes (MDS) are a group of malignant cancers. In MDS, the bone marrow does not produce healthy blood cells.

Haematopoietic stem cell transplantation (HSCT) is one treatment for MDS. In HSCT, the patient receives stem cells from the bone marrow of a person who does not have MDS. Before the treatment starts, the patient's faulty bone marrow is destroyed.

0 6 . 1 For some patients, HSCT is an effective treatment for MDS.

Explain how.

[3 marks]

0 6 . 2 MDS can develop from epigenetic changes to tumour suppressor genes. In some patients, the drug AZA has reduced the effects of MDS. AZA is an inhibitor of DNA methyltransferases. These enzymes add methyl groups to cytosine bases.

Suggest and explain how AZA can reduce the effects of MDS in some patients.

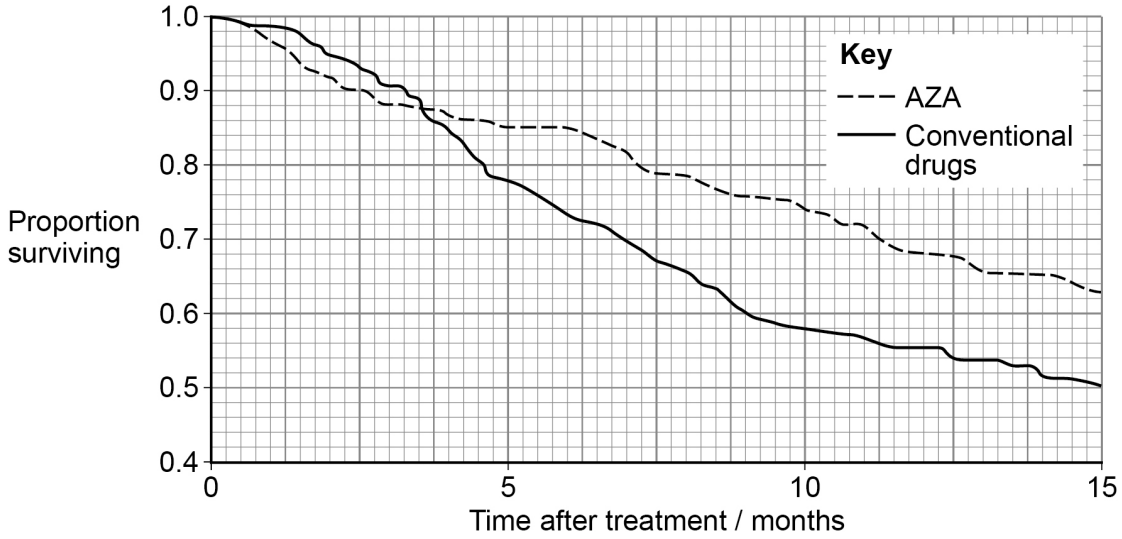
[3 marks]

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Scientists investigated the effectiveness of AZA in patients with MDS.
A total of 360 patients were randomised in the ratio of 1:1 to receive AZA or conventional drugs (control).

Figure 6 shows the scientists' results.

Figure 6



0 6 . 3 The control patients were treated with conventional drugs.

Give **two** reasons why.

[2 marks]

1 _____

_____

2 _____

_____

0 6 . 4 Use **Figure 6** and the information provided to calculate the difference in the number of patients surviving at 10 months after treatment with AZA compared with conventional drugs.

[2 marks]

Answer _____

10

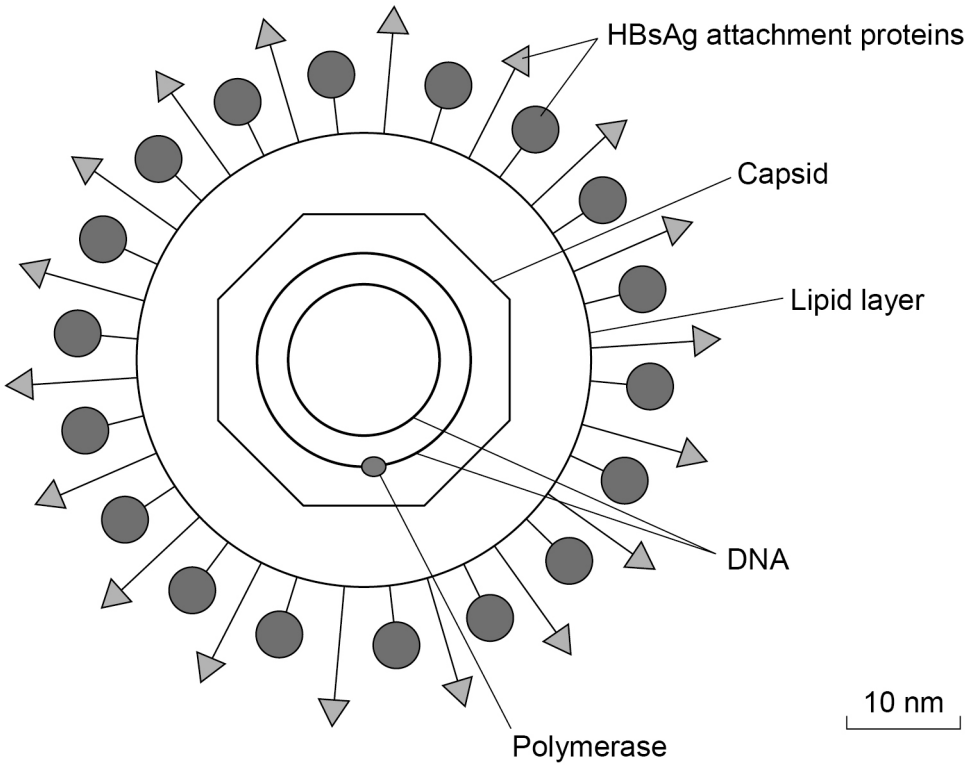
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0 7 Hepatitis B is a life-threatening liver infection caused by the hepatitis B virus (HBV).

Figure 7 shows the structure of HBV.

Figure 7



0 7 . 1 HBV infects a liver cell. The liver cell is 25 µm in diameter.

Use **Figure 7** to calculate how many times larger in diameter this cell is than HBV.
You should use the lipid layer to measure the diameter of HBV.

[2 marks]

Answer _____ times larger

Do not write outside the box

Scientists investigated the effectiveness of two types of RNA interference (RNAi) molecules on reducing HBV replication. These molecules were:

- short hairpin RNA (shRNA)
- long hairpin RNA (lhRNA).

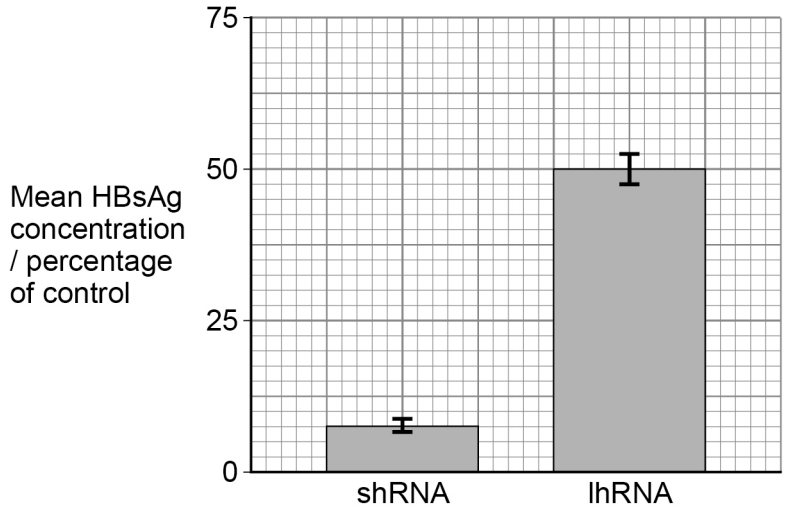
The scientists infected mouse liver cells with HBV and transferred either shRNA or lhRNA into these cells. Then they determined the concentration of the attachment proteins, HBsAg, in these cells.

The concentration of HBsAg is a measure of HBV replication.

Figure 8 shows the scientists' results.

The error bars represent ±2 standard deviations from the mean, which includes over 95% of the data.

Figure 8



0 7 . 2 One method of transferring RNAi molecules into cells involves combining these molecules with a lipid. Suggest why this increases uptake of RNAi molecules into cells.

[1 mark]

Question 7 continues on the next page

Do not write outside the box

0 7 . 3 Using all the information provided, evaluate the use of the two types of RNAi in treating hepatitis B in humans.

Do **not** refer in your answer to how RNAi reduces HBV replication.

[5 marks]

8

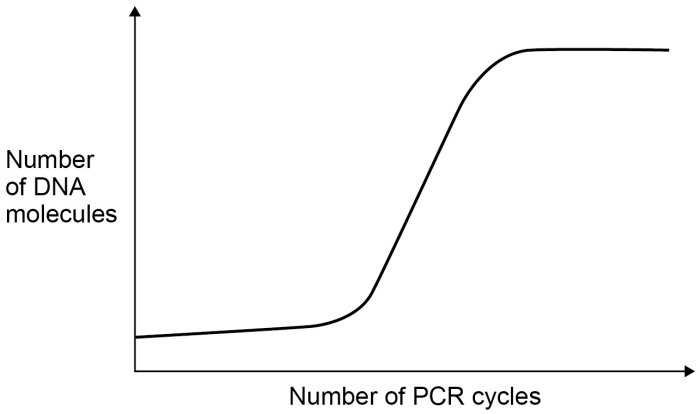
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0 8 . 1 Describe and explain how the polymerase chain reaction (PCR) is used to amplify a DNA fragment.

[4 marks]

Figure 9 shows the number of DNA molecules produced using a PCR.

Figure 9



0 8 . 2 Explain the shape of the curve in **Figure 9**.

[2 marks]

6

Turn over ►

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0 9 A coral reef is an underwater ecosystem formed as a ridge of mainly calcium carbonate deposits. Algae are photosynthesising organisms. Some algae grow on coral reefs. Succession results in a wide variety of fish living on coral reefs.

0 9 . 1 Describe a method that could be used to determine the mean percentage cover of algae on a coral reef.

Do **not** include information on the difficulties of using your method underwater.

[3 marks]

0 9 . 2 Explain how succession results in a wide variety of fish living on coral reefs.

Do **not** describe the process of succession in your answer.

[2 marks]

Do not write outside the box

Ecologists investigated the effect of two fish species, the redband parrotfish and the ocean surgeonfish, on algal growth on an artificial reef. They made this artificial reef by submerging many large concrete blocks at a depth of 16–18 metres off the coast of Florida. They attached four large wire cages, **A**, **B**, **C** and **D**, to each block and populated the cages as shown.

A – No fish

B – Two redband parrotfish

C – Two ocean surgeonfish

D – One redband parrotfish and one ocean surgeonfish

After 34 weeks, the ecologists measured the mean percentage cover of all algae within each set of wire cages. The ecologists used a statistical test to find out whether the mean for each set of cages was significantly lower than the mean for set **A**.

Table 3 shows the probability (P) values that the ecologists obtained using this statistical test.

Table 3

Set of cages	P value
B	=0.841
C	<0.001
D	=0.634

0 9 . 3 Using all the information, evaluate the effect of the two fish species on algal growth on coral reefs.

[5 marks]

10

Turn over ►

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1 0 Read the following passage.

Lake Malawi in East Africa has more species of fish than any other lake in the world. Many of these species have evolved from a common ancestor. Lake Malawi is one of the largest lakes in the world and was formed several million years ago. Since then, the water level has fluctuated greatly. As a result, what is now a large lake was at one time many smaller, separate lakes.

The country of Malawi has a total area of 118 000 km^2. The actual land area is only 94 080 km^2, because approximately one-fifth of the country is Lake Malawi.

In December 1990, forests covered 41.4% of the actual land area of Malawi. In December 2016, forests covered 26.4% of the actual land area of Malawi.

Deforestation and farming along the shores of Lake Malawi have caused increased soil erosion and loss of nutrients into the lake. This has resulted in a decrease in some fish populations. The mark-release-recapture method can be used to estimate the size of a fish population. However, this method can produce unreliable results in very large lakes.

Use the information in the passage and your own knowledge to answer the following questions.

1 0 . 1 Lake Malawi in East Africa has more species of fish than any other lake in the world (line 1).

Suggest and explain how this speciation may have occurred.

[4 marks]

Do not write outside the box

1 0 . 2 The percentage of forest cover in Malawi decreased between December 1990 and December 2016 (lines 9–10).

Calculate the mean loss of forest cover in km^2 per week during this time period.

[2 marks]

Answer _____ km^2 per week

1 0 . 3 Loss of nutrients **into** Lake Malawi has resulted in a decrease in some fish populations (lines 12–13).

Explain why.

[4 marks]

Do not write outside the box

1 0 . 4 The mark-release-recapture method can be used to estimate the size of a fish population (lines 13–14).

Explain how.

[4 marks]

1 0 . 5 Suggest why the mark-release-recapture method can produce unreliable results in very large lakes (lines 14–15).

[1 mark]

15

END OF QUESTIONS

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