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National Qualifications 2025

Mark

X807/76/01

Biology Paper 2

TUESDAY, 27 MAY

10:10 AM – 12:30 PM

X8077601

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth

Day

Month

Year

Scottish candidate number

Total marks — 95

Attempt ALL questions.

You may use a calculator.

Questions 5 and 15 contain a choice.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. Score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

SQA ©

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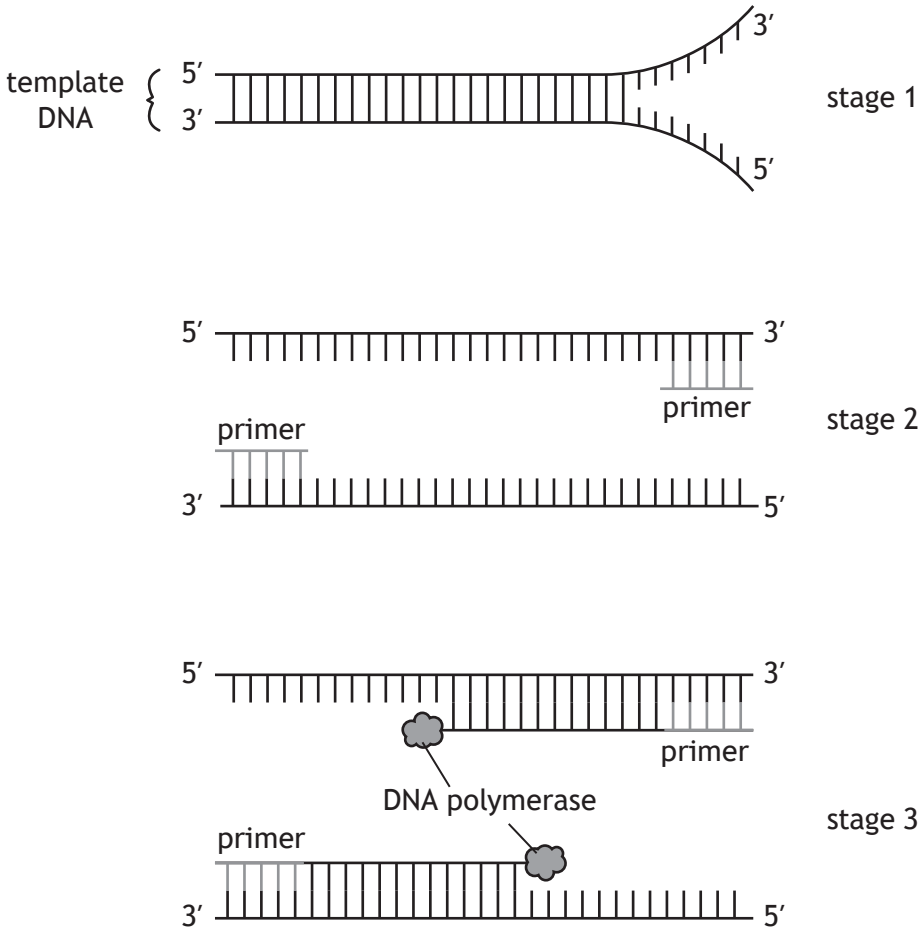
Total marks — 95

Attempt ALL questions

Questions 5 and 15 contain a choice

1. The diagram shows the stages that take place in a complete cycle of the polymerase chain reaction (PCR) being used to amplify human DNA.



(a) Name the part of a nucleotide found at the 3′ end of a DNA strand. **1**

(b) (i) State a temperature required for stage 3 to occur. **1**

°C

(ii) Describe the role of DNA polymerase in stage 3. **1**

1. **(continued)**

(c) (i) Explain why the enzyme ligase is **not** required in PCR. **1**

(ii) Explain why DNA polymerase extracted from human cells would **not** be suitable for PCR. **1**

(d) The table shows the contents of a reaction tube used in PCR.

Content of reaction tube	Volume (µL)
Distilled water	15.8
Buffer	2.4
Nucleotides	1.7
Magnesium chloride	2.1
Primers	2.0
DNA polymerase	0.4
Template DNA	0.6

Calculate the percentage of the contents of the reaction tube that is DNA polymerase. **1**

Space for calculation

%

(e) The original sample used contained 70 DNA molecules.

Calculate how many copies of DNA there would be after 8 cycles of PCR. **1**

Space for calculation

2. The MSTN gene in cattle codes for the protein myostatin. Myostatin inhibits the growth of muscle tissue.

A mutation can occur in the MSTN gene.

Part of the base sequence of the MSTN gene in two breeds of cattle is shown.

Breed A ....C C C A C G G A G T G T G A G T A G....

Breed B ....C C C A C G G A G T T G A G T A G....

Breed A does not have the mutation and breed B does have the mutation in the MSTN gene.

(a) (i) Name the type of gene mutation that has occurred in breed B. **1**

(ii) Explain why there would be a major effect on the structure of the protein produced. **1**

(b) Explain why breed B cattle will have an increase in muscle mass. **1**

2. (continued)

(c) The length of pregnancy and birth mass of beef and dairy cattle breeds were recorded.

The results are shown in the table.

Breed of cattle	Product	Average length of pregnancy (days)	Average birth mass (kg)
Aberdeen Angus	beef	285	34.6
Ayrshire	dairy	280	37.2
Hereford	beef	284	35.3
Holstein	dairy	277	38.2
Jersey	dairy	275	36.9

Compare the length of pregnancy and birth mass of beef and dairy cattle. **2**

[Turn over

3. In Lake Victoria there are two populations of male cichlid fish. One population is red and the other is blue.

The fish move freely between shallow and deep water. In shallow water, female cichlid fish are only attracted to and breed with blue males. In deeper water, females are only attracted to and breed with red males.

(a) (i) Name the type of isolation barrier that exists between these populations. **1**

(ii) State the importance of isolation barriers in the evolution of new species. **1**

(b) An investigation was carried out into the effect of the depth of water on the distribution of blue and red male cichlid fish. The fish were counted using underwater video cameras.

The results are shown in the table.

Depth of water (m)	Number of blue male cichlid fish	Number of red male cichlid fish
0–10	9924	57
10–20	7587	84
20–30	4457	119
30–40	301	6650
40–50	103	9210
50–60	74	11 570

(i) Predict the number of red male cichlid fish at a depth of 60–70 m. **1**

(ii) Suggest a reason why the method used to count the cichlid fish could lead to inaccurate results. **1**

3. (b) (continued)

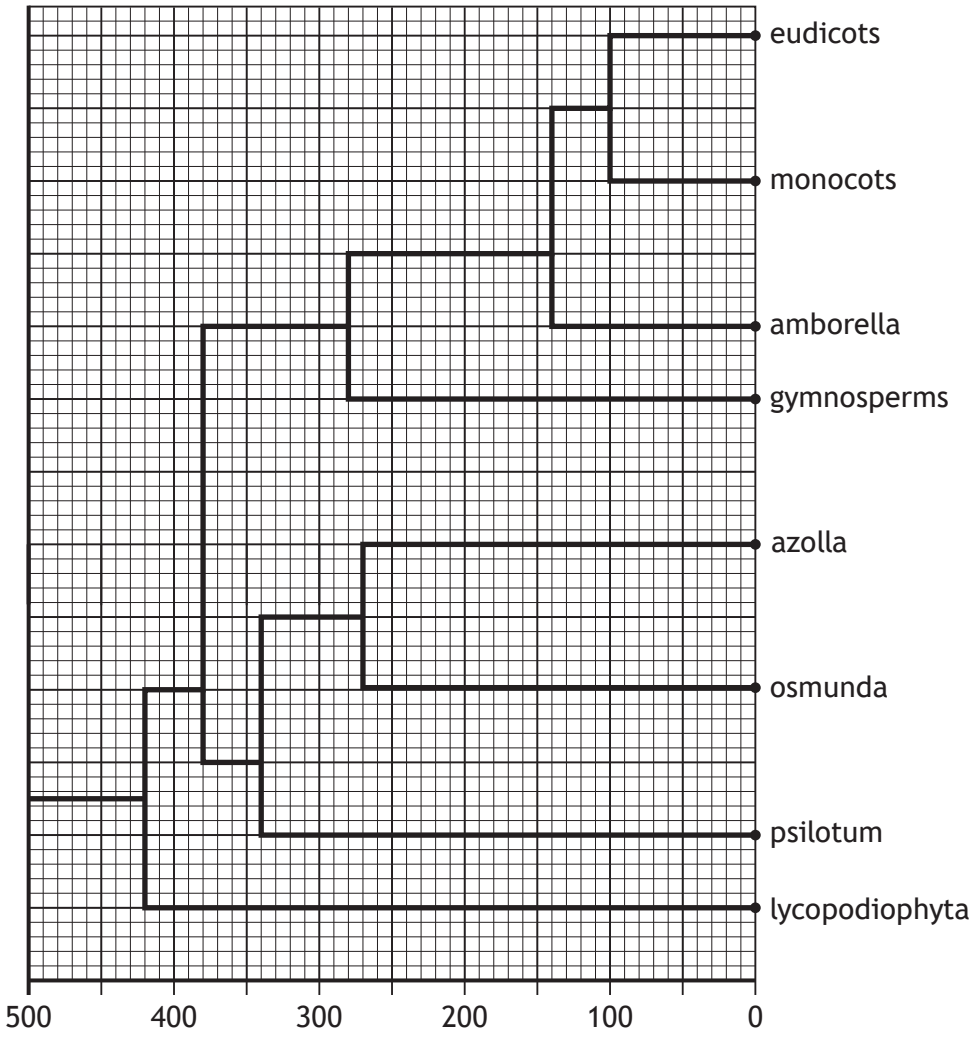
(iii) Compare the distribution of blue and red male fish as the depth of water increases. **1**

(c) It is predicted that these two populations will evolve into different species.

State how it could be proved that they are no longer the same species. **1**

[Turn over

4. The phylogenetic tree shown illustrates the evolutionary relatedness of eight groups of land plants.



(a) (i) Phylogenetics uses fossil evidence to study evolutionary relatedness.

Name another type of evidence required to construct a phylogenetic tree. **1**

(ii) Using information from the diagram state when the last common ancestor of amborella and osmunda lived. **1**

millions of years ago

(iii) State how many groups of land plants monocots shared a common ancestor with 200 million years ago. **1**

4. (a) (continued)

(iv) Monocots are more closely related to gymnosperms than to lycopodiophyta.

Use information from the diagram to justify this statement. **1**

(b) The ACS gene is found in the eudicot plant group genome. Several different enzymes can be expressed from this gene.

(i) State the definition of a genome. **1**

(ii) In terms of gene expression, describe how different enzymes can be produced from a single ACS gene. **2**

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

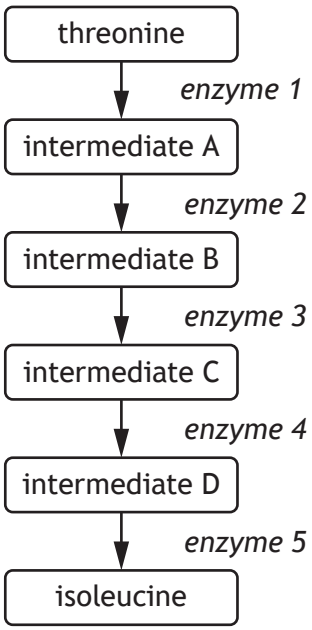
5. Attempt **either A or B**. Write your answer in the space below.

A Write notes on the transcription stage of gene expression. **4**

OR

B Write notes on chromosome mutations. **4**

6. The diagram shows a metabolic pathway, which converts the amino acid threonine to another amino acid isoleucine in cells.



Enzyme 1 catalyses the breakdown of threonine to intermediate A.

(a) (i) Name this type of metabolic reaction. **1**

(ii) Describe what happens to the active site of enzyme 1 when threonine binds to it and explain how this increases the rate of reaction. **2**

Description

Explanation

[Turn over

6. (continued)

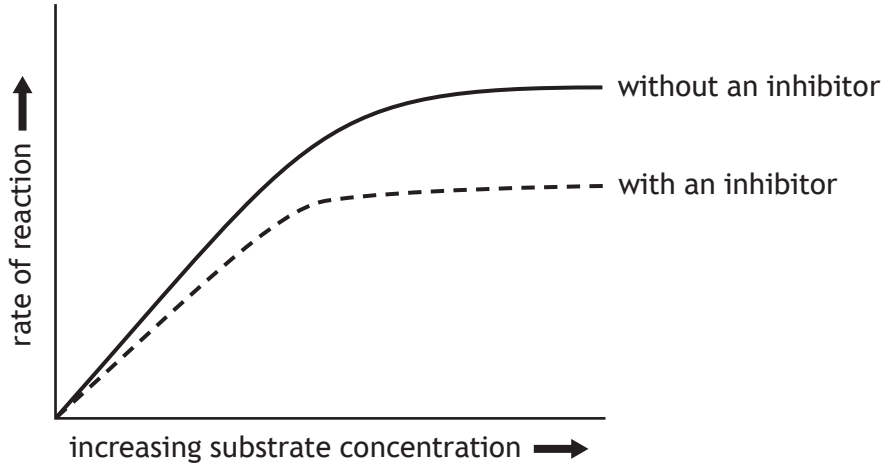
(b) When concentrations of isoleucine reach a high level, the metabolic pathway is blocked.

Describe how this happens and suggest how this is an advantage to the cell. **2**

Description

Advantage

(c) The graph shows the rate of isoleucine synthesis with and without an inhibitor.



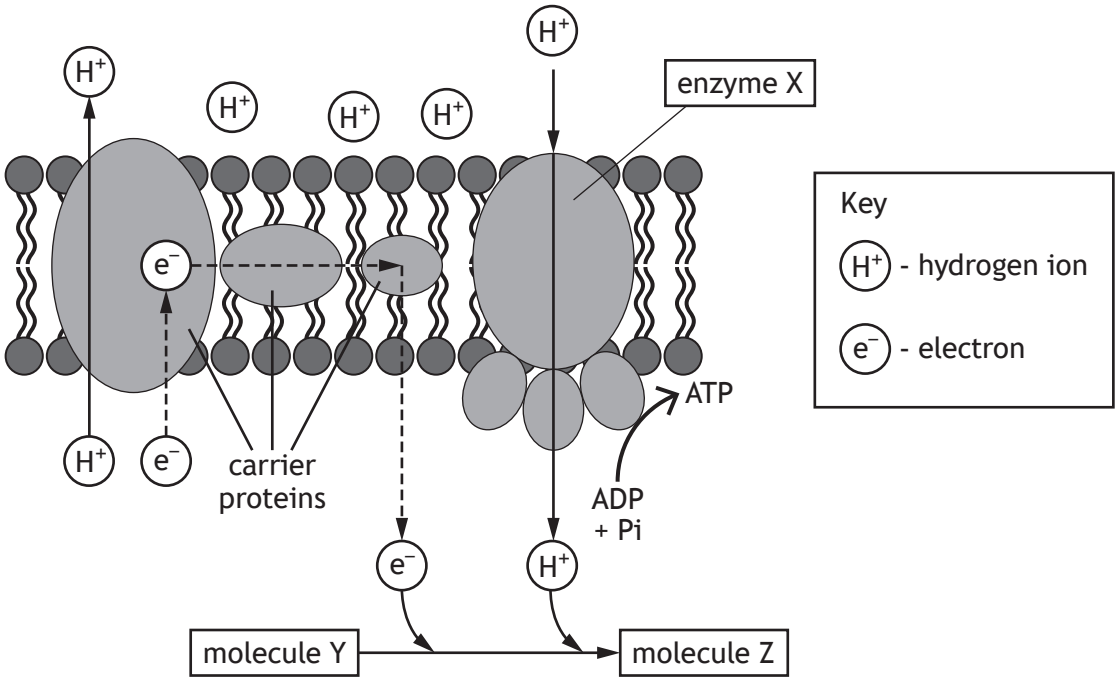
(i) Explain why the rate of reaction levels off at high substrate concentrations without an inhibitor. **1**

(ii) This is an example of non-competitive inhibition.

Use information from the graph to support this statement. **1**

7. The diagram illustrates how ATP is produced in the electron transport chain.

MARKS DO NOT WRITE IN THIS MARGIN



(a) (i) State the exact location of the electron transport chain in eukaryotic cells. **1**

(ii) Name enzyme X. **1**

(iii) Name molecules Y and Z. **2**

Y Z

(b) Describe the role of the co-enzyme NAD. **2**

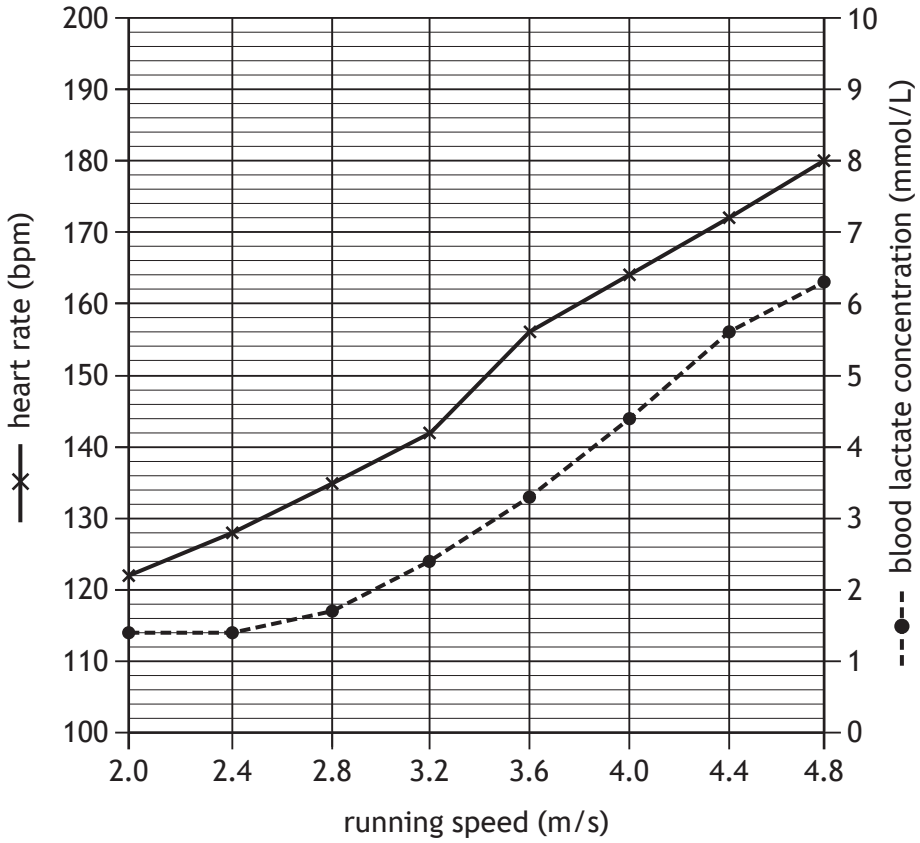
(c) Mitochondrial disease can be caused by a mutation that alters the structure of the carrier proteins shown in the diagram.

Suggest how the altered structure of these proteins can lead to reduced ATP production in individuals with this mutation. **2**

MARKS | DO NOT WRITE IN THIS MARGIN

8. In an investigation an athlete ran at different speeds on a treadmill. Their heart rate and blood lactate concentration were measured at each running speed.

The results are shown in the **graph**.



(a) (i) Use values from the graph to describe changes in blood lactate concentration as running speed increased from 2.0 to 4.8 m/s. **2**

(ii) State the blood lactate concentration when heart rate was 135 bpm. **1**

mmol/L

(iii) Calculate the percentage increase in heart rate as running speed increased from 2.0 to 4.8 m/s. **1**

Space for calculation

%

8. (continued)

(b) The power generated by the same athlete at different heart rates was calculated in another investigation on the same treadmill.

The results are shown in the **table**.

Heart rate (bpm)	Power (watts)
84	120
92	135
112	148
140	162
164	184

(i) Calculate the average increase in power generated as the heart rate increases from 84 to 164 bpm. **1**

Space for calculation

watts per bpm

(ii) **Using information in the graph and table** state the athlete's blood lactate concentration when they generated 184 watts. **1**

mmol/L

(c) Name the cell process that produces lactate. **1**

(d) The athlete's blood lactate concentration was recorded 10 minutes after they finished running and it had decreased to 1.1 mmol/L.

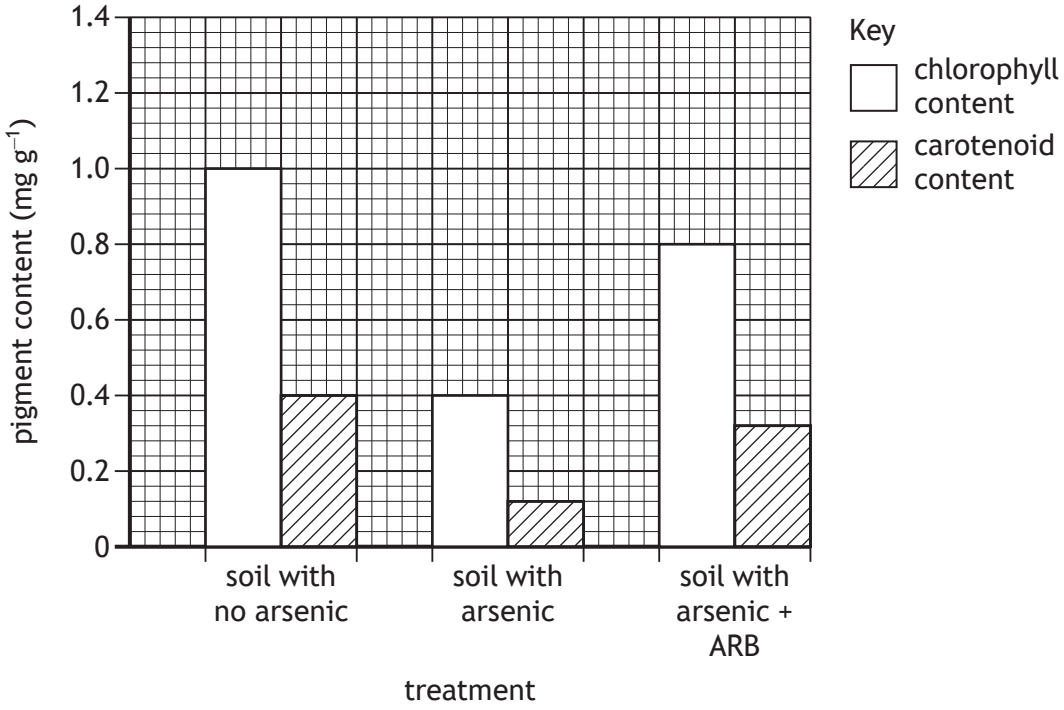
Explain this observation. **1**

9. Some areas of agricultural land are contaminated with arsenic. This can reduce the pigment content in crop plants.

A strain of bacteria, called ARB, breaks down arsenic in contaminated soils.

An investigation was carried out to determine the effect of adding ARB to soil on the chlorophyll and carotenoid content of plants.

The results are shown in the graph.



(a) (i) Express, as a simple whole number ratio, the carotenoid content of the plants grown in soil with no arsenic, soil with arsenic, and soil with arsenic + ARB. **1**

Space for calculation

soil with no arsenic : soil with arsenic : soil with arsenic + ARB

(ii) Describe evidence from the graph that suggests that not all arsenic has been broken down by ARB. **1**

9. (a) (continued)

(iii) Explain why the presence of carotenoids increases the rate of photosynthesis. **2**

(b) Describe how the absorbed light leads to the production of ATP, which is required for carbon fixation. **2**

[Turn over

10. Selective herbicides can be used to control weeds growing in wheat fields.

(a) (i) State why the presence of weeds reduces the productivity of wheat plants. **1**

(ii) Explain why selective herbicides have a greater effect on some weeds compared to wheat plants. **1**

(b) The global human population and the number of species of herbicide-resistant weeds were recorded from 1980 until 2020.

The results are shown in the table.

Year	Global human population (billions)	Number of herbicide-resistant weed species
1980	4.4	8
1990	5.3	113
2000	6.1	264
2010	7.0	404
2020	7.8	480

(i) Calculate how many times greater the number of herbicide-resistant species was in 2020 compared to 1980. **1**

Space for calculation

times

10. (b) (continued)

(ii) Use information from the table to suggest why there was a decrease in global food security between 1980 and 2020. **2**

(c) In terms of natural selection, explain how the use of herbicides results in an increase in the number of herbicide-resistant weed species. **2**

[Turn over

11. Problems with pesticides include toxicity to non-target species. Sumithion is an insecticide used to control tiger beetles, which are pests in fish farms.

An investigation was carried out into the effect of sumithion concentration on hatching success of fish eggs.

40 fertilised fish eggs were placed in containers with 250 cm^3 of water and different concentrations of sumithion. The hatching success was recorded after 20 days.

The results are shown in the table.

Sumithion concentration (mg/L)	Hatching success (%)
0.0	92
0.2	85
0.4	57
0.6	42
0.8	25
1.0	25

(a) (i) Name the independent variable. **1**

(ii) Identify one variable, not already mentioned, that should have been controlled to allow a valid conclusion to be drawn. **1**

(iii) Identify the sumithion concentration that acts as a control and describe the purpose of the control in **this** investigation. **2**

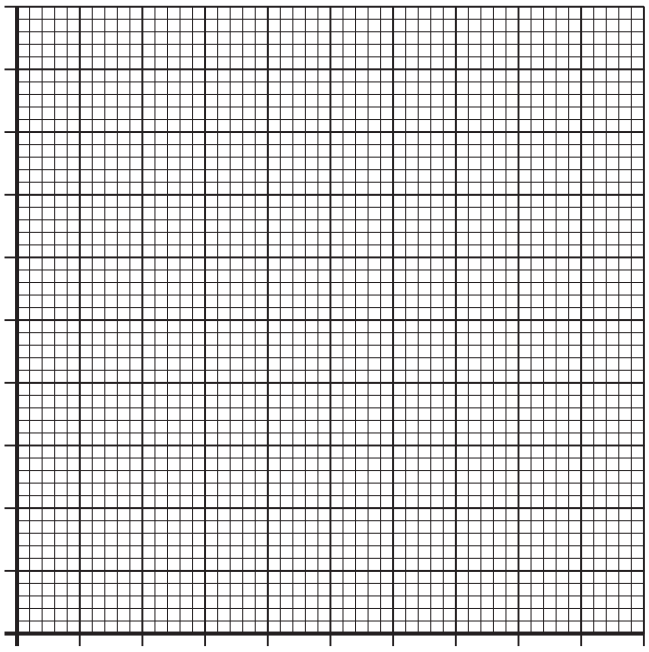
Sumithion concentration _____ mg/L

Purpose of the control _____

11. (continued)

(b) On the grid, draw a line graph using the results in the table. **2**

(Additional graph paper, if required, can be found on *page 30*.)



(c) State the conclusion from the results of the investigation. **1**

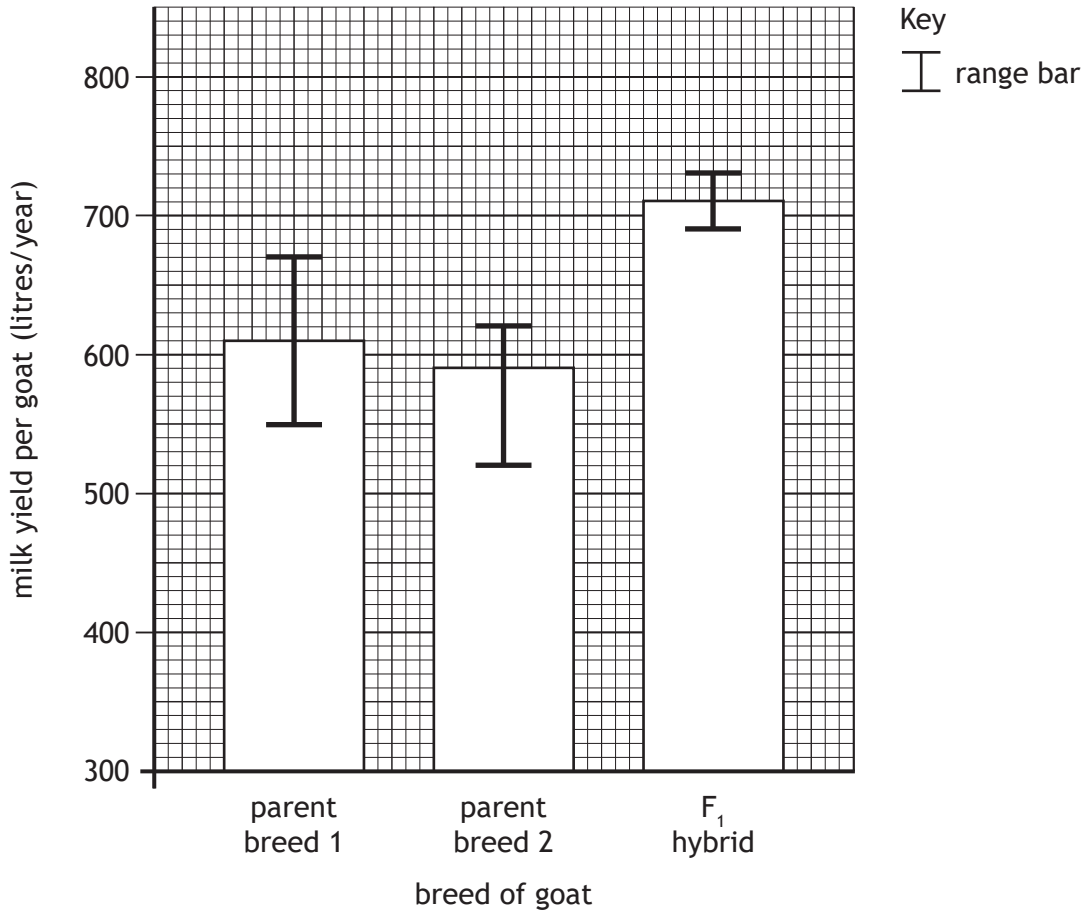
(d) State a problem with pesticide use, other than toxicity to non-target species. **1**

[Turn over

12. Different breeds of goat can be crossbred to produce F_1 hybrids that have increased milk production.

In an investigation, the milk yields from the two parent breeds of goat and the F_1 hybrid were measured.

The results are shown in the graph. The bars show the average milk yield of 10 goats per group. The range bars show the range of milk yields in each group.



(a) (i) Calculate the difference in the lowest and highest milk yield from individual goats in this investigation. **1**

Space for calculation

litres/year

(ii) State how the graph shows that milk yield was measured from more than one goat of each breed. **1**

12. (continued)

(b) An F_2 population was produced by breeding F_1 hybrids together. Some individual goats within this population showed a decrease in milk yield compared with the F_1 hybrid.

Suggest why this decrease occurred. **1**

(c) Some goats are intensively farmed. They are kept in buildings, which can lead to overcrowding and poor ventilation.

(i) State one advantage to the farmer of intensive farming. **1**

(ii) Suggest a reason why parasites can spread rapidly in intensive farms. **1**

(iii) Animals that are intensively farmed often display signs of poor welfare, such as altered levels of activity.

State the term used to describe very high levels of activity. **1**

[Turn over

13. Some species of bee live in large colonies. However, some species are solitary and live alone. Females of these solitary species lay eggs in holes in the ground. They collect pollen and put it in the holes as food for their larvae, which hatch from the eggs.

As the solitary bee does not guard her eggs, a species of fly can lay eggs in the same hole and the fly offspring eat the pollen intended for the bee larvae.

(a) The fly offspring are parasites.

Justify this statement. **2**

(b) These flies rarely lay eggs in the hives of social bees that live in colonies with many members.

Suggest why it would be difficult for the fly to lay eggs in a social beehive. **1**

(c) In social bees, most members of the colony are sterile and cooperate to raise the young.

Describe how this behaviour benefits the sterile bees. **1**

14. African wild dogs hunt in packs.

(a) (i) Pack members work together to chase down prey, increasing hunting success.

Name this type of behaviour. **1**

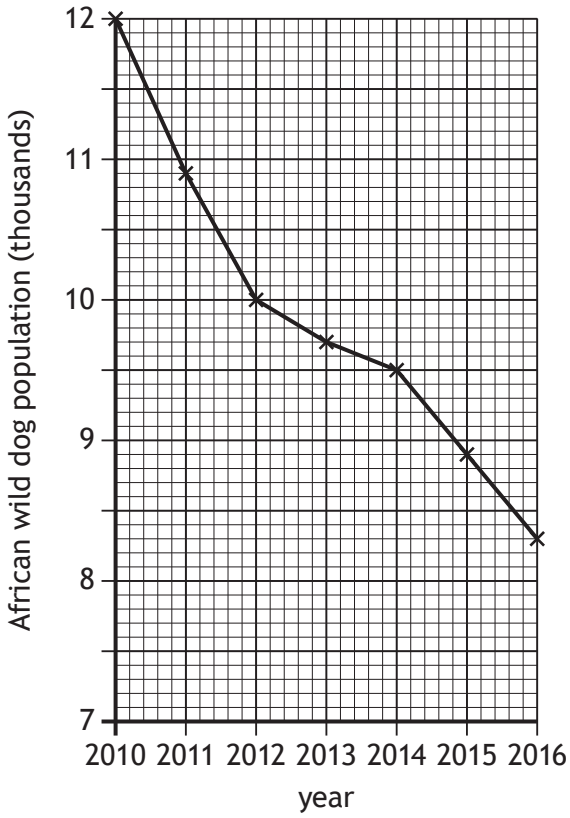
(ii) State an advantage, not already mentioned, of hunting in packs. **1**

[Turn over

14. (continued)

(b) A survey was carried out between 2010 and 2016 to estimate the population of African wild dogs.

The results are shown in the graph.



Using information from the graph, predict the estimated population of African wild dogs in 2018. **1**

_____ thousand

(c) It has been proposed that habitat fragmentation has caused the decrease in population size of African wild dogs.

Name a method used to reduce the effect of habitat fragmentation and explain how it could result in the recovery of African wild dog numbers. **2**

Method _____

Explanation _____

_____

MARKS | DO NOT WRITE IN THIS MARGIN

15. Attempt **either A or B**. Write your answer in the space below and on *pages 28* and *29*.

A Write notes on how animals survive adverse conditions. **7**

OR

B Write notes on the phases of growth of micro-organisms. **7**

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWER to question 15

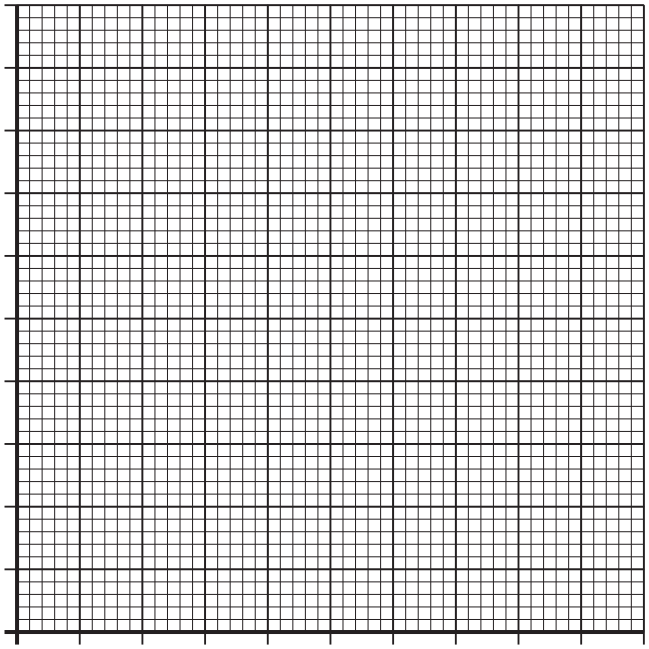
MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWER to question 15

[END OF QUESTION PAPER]

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph paper for question 11 (b)



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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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