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National Qualifications 2024

Mark

X807/76/01

Biology Paper 2

WEDNESDAY, 15 MAY
10:10 AM – 12:30 PM

* X 8 0 7 7 6 0 1 *

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 9 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 ©

* X 8 0 7 7 6 0 1 0 1 *

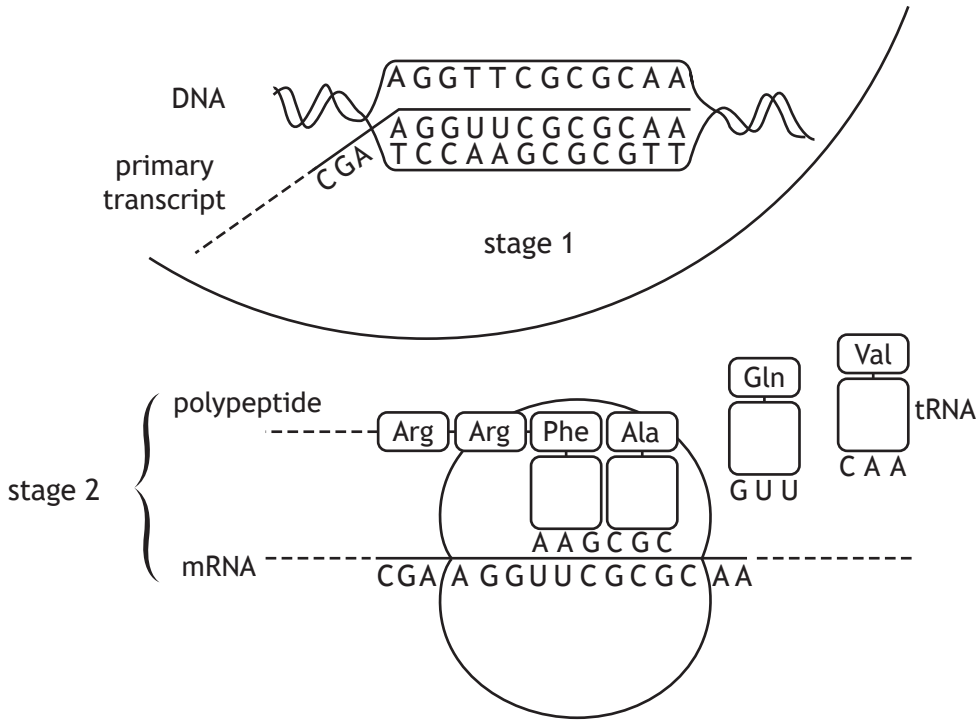
Total marks — 95

Attempt ALL questions

Questions 9 and 15 contain a choice

MARKS | DO NOT WRITE IN THIS MARGIN

1. The diagram shows stages of protein synthesis in a cell.



(a) Name stage 2 and state the site where it occurs. **2**

Stage _____

Location _____

(b) The total length of the primary transcript is 3000 bases. Introns make up 40% of the bases.

(i) Calculate the length of the mature transcript produced after RNA splicing. **1**

Space for calculation

_____ bases

(ii) Name the process that could result in different lengths of mature transcript being produced from this primary transcript. **1**

_____

MARKS

DO NOT WRITE IN THIS MARGIN

(c) The table shows the amino acids produced from specific mRNA codons. It also shows stop codon sequences.

FIRST BASE	SECOND BASE				THIRD BASE
	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	STOP	STOP	A
	Leu	Ser	STOP	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

(i) Which amino acid is coded for by the codon CAU? **1**

_____

(ii) The sequences show the effect of a substitution mutation on a section of DNA in a gene.

Sequence before mutation: TAT AGT CCC ATA GTC AGC CAC

Sequence after mutation: **TAT AGT CCC ATT GTC AGC CAC**

Using all the information provided explain the effect this mutation would have on the mature transcript and the protein synthesised. **2**

_____

_____

_____

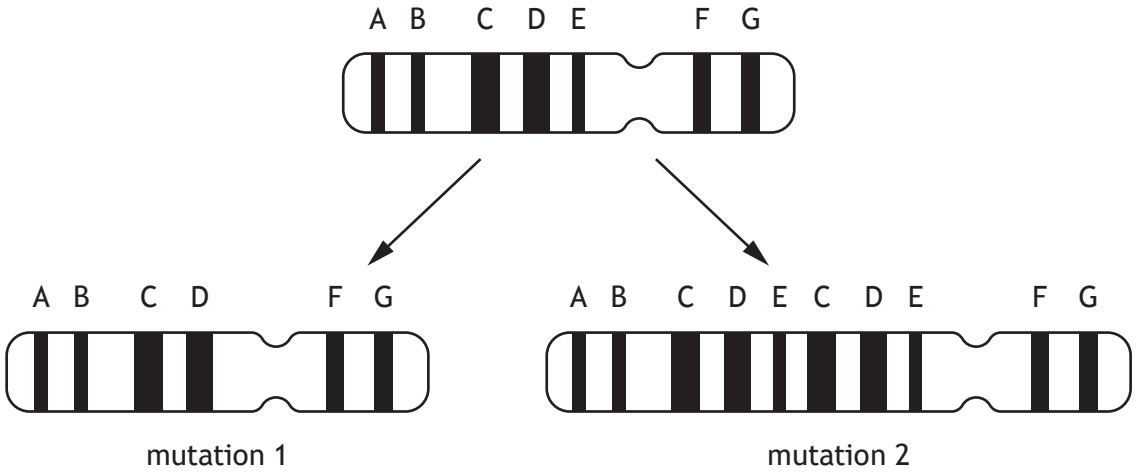
2. In human cells chromosome 22 contains 51 million DNA base pairs, which represents 1.6% of the entire human genome.

(a) Calculate how many base pairs the human genome contains. **1**

Space for calculation

_____ million base pairs

The diagrams show the position of genes A–G on chromosome 22 before and after two different chromosome mutations.



mutation 1 mutation 2

(b) (i) Name these chromosome mutations. **2**

Mutation 1 _____

Mutation 2 _____

(ii) Chromosome mutation 1 results in DiGeorge syndrome, which can have a major effect on the development of some body systems.

Suggest why this mutation can have such an effect. **1**

_____

_____

2. (continued)

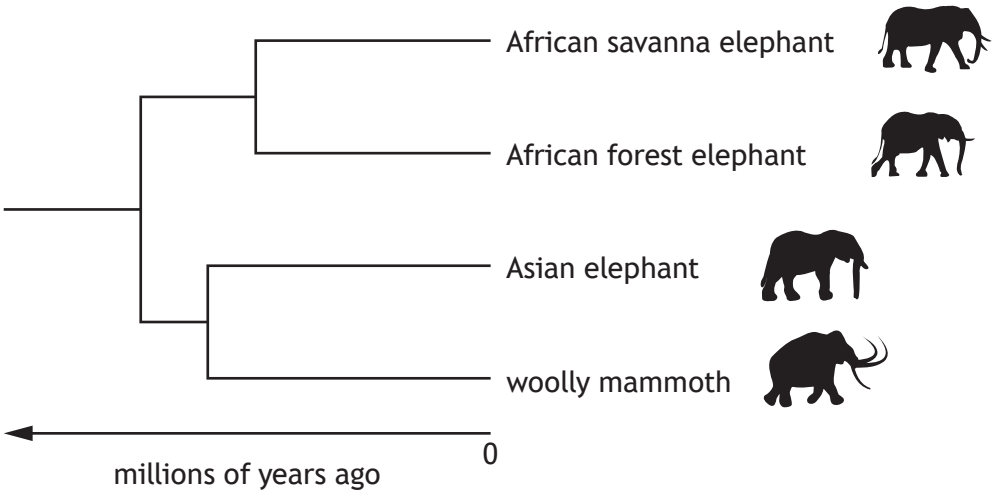
(c) (i) Describe how mutation 2 has occurred. **1**

(ii) Explain why this type of chromosome mutation can be important in evolution. **2**

[Turn over

3. The diagram shows the evolutionary relatedness of three species of elephant and the woolly mammoth, which became extinct 4000 years ago.

Elephants and woolly mammoths are closely related, as shown in the diagram.



(a) (i) What name is given to the study of evolutionary relatedness of different species? **1**

_____

(ii) State two types of evidence used to determine the order of events shown in the diagram. **2**

1. _____

2. _____

(b) Proteins from a woolly mammoth, found preserved in ice, have been isolated and sequenced.

Bioinformatics can be used to compare the amino acid sequence of a specific protein from the woolly mammoth and species of elephant.

(i) State one type of analysis used in bioinformatics. **1**

_____

(ii) Explain why the amino acid sequences of the Asian elephant would be more similar to the woolly mammoth sequences than to those of the other elephants. **1**

_____

_____

4. Succinate dehydrogenase is an enzyme involved in aerobic respiration. It is found in the matrix of the mitochondria and catalyses the reaction shown.

$$\text{succinate} \xrightarrow{\textit{succinate dehydrogenase}} \text{fumarate} + \text{hydrogen}$$

(a) Name the stage of aerobic respiration that occurs in the matrix of the mitochondria. **1**

_____

(b) (i) The active site of succinate dehydrogenase changes shape after succinate binds to it.

Name this process. **1**

_____

(ii) Fumarate has a lower affinity than succinate for the active site.

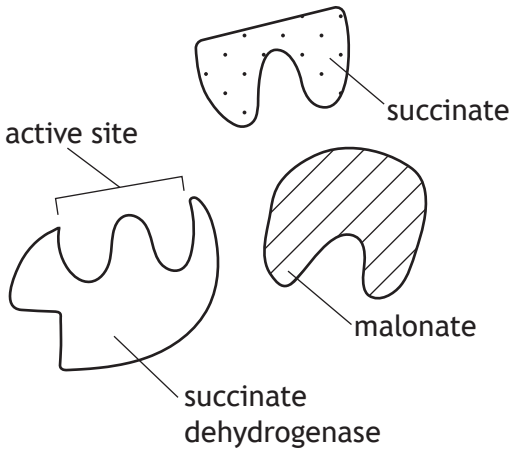
Describe the importance of this difference. **1**

_____

_____

(c) The molecule malonate inhibits the enzyme succinate dehydrogenase.

The diagram represents the shapes of the enzyme, succinate, and malonate.



Using information from the diagram, name the type of inhibition that malonate causes and justify your answer. **2**

Type of inhibition _____

Justification _____

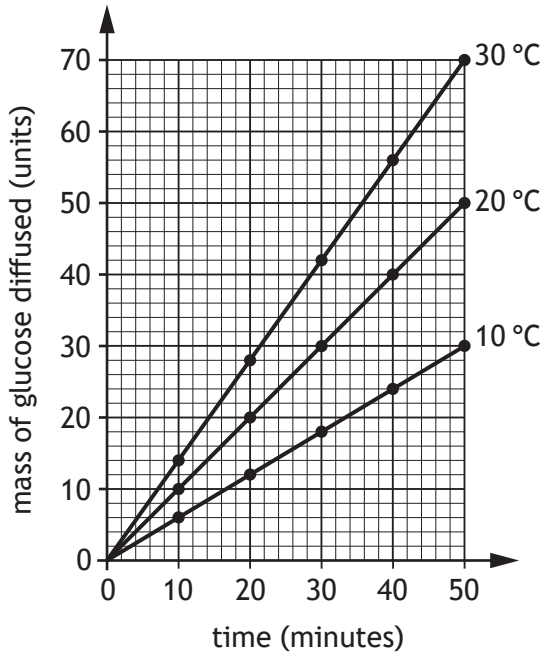
_____

5. Thermoregulation is important in regulators to maintain high diffusion rates.

MARKS DO NOT WRITE IN THIS MARGIN

An investigation was carried out into the effect of temperature on the rate of diffusion of glucose into tissue. Four samples of muscle tissue were each incubated at three different temperatures in media containing glucose. The mass of glucose that diffused into the tissue was measured every 10 minutes for 50 minutes.

The results are shown in the graph.



(a) State one variable that should be controlled so that a valid conclusion could be drawn. **1**

_____

(b) (i) Calculate how many times greater the mass of glucose diffused at 30 minutes was at 30 °C compared to 10 °C. **1**

Space for calculation

_____

(ii) Predict the expected mass of glucose diffused if the experiment was carried out at 10 °C for 70 minutes. **1**

Space for calculation

_____ units

5. (continued)

(c) Suggest why high diffusion rates are important for regulators. **2**

(d) Regulators increase their metabolic rate when there is a decrease in body temperature.

Describe one other corrective response to a decrease in body temperature.

Explain how this response returns body temperature to normal. **2**

Description

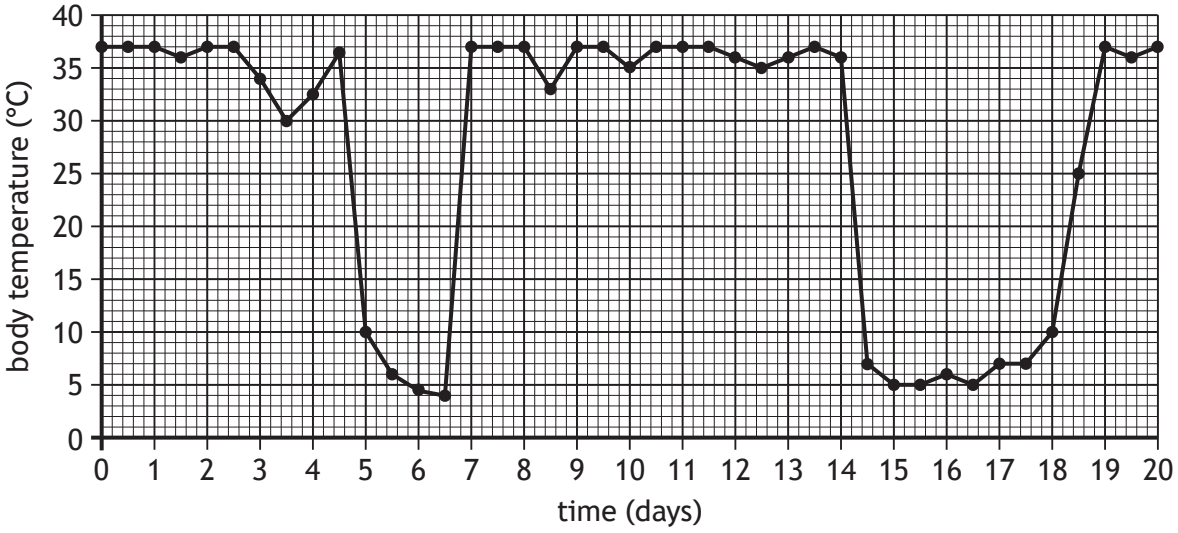
Explanation

[Turn over

6. (a) Arctic ground squirrels are found in Alaska and survive low winter temperatures by becoming dormant for short periods of time.

To study dormancy in an Arctic ground squirrel, its body temperature was measured over a period of 20 days in winter.

The results are shown in the graph.



(i) Calculate the total time that the Arctic ground squirrel's body temperature was 10 °C or below. **1**

Space for calculation

_____ days

(ii) Apart from decreasing body temperature, state another change that may be observed in an Arctic ground squirrel during dormancy. **1**

_____

MARKS

DO NOT WRITE IN THIS MARGIN

(b) The Alaskan brown bear hibernates during winter. The average monthly air temperatures in Alaska are shown in the table.

Month	Average air temperature (°C)
January	–28
February	–29
March	–28
April	–21
May	–9
June	–1
July	2
August	2
September	–2
October	–11
November	–20
December	–25

(i) Calculate the average monthly decrease in air temperature over the four-month period from the beginning of August until the end of November. **1**

Space for calculation

_____ °C per month

(ii) Alaskan brown bears hibernate between August and April.

Use information in the table to identify the type of dormancy.

Give a reason for your answer. **2**

Type of dormancy _____

Reason _____

_____

(iii) State one advantage of hibernation to Alaskan brown bears. **1**

_____

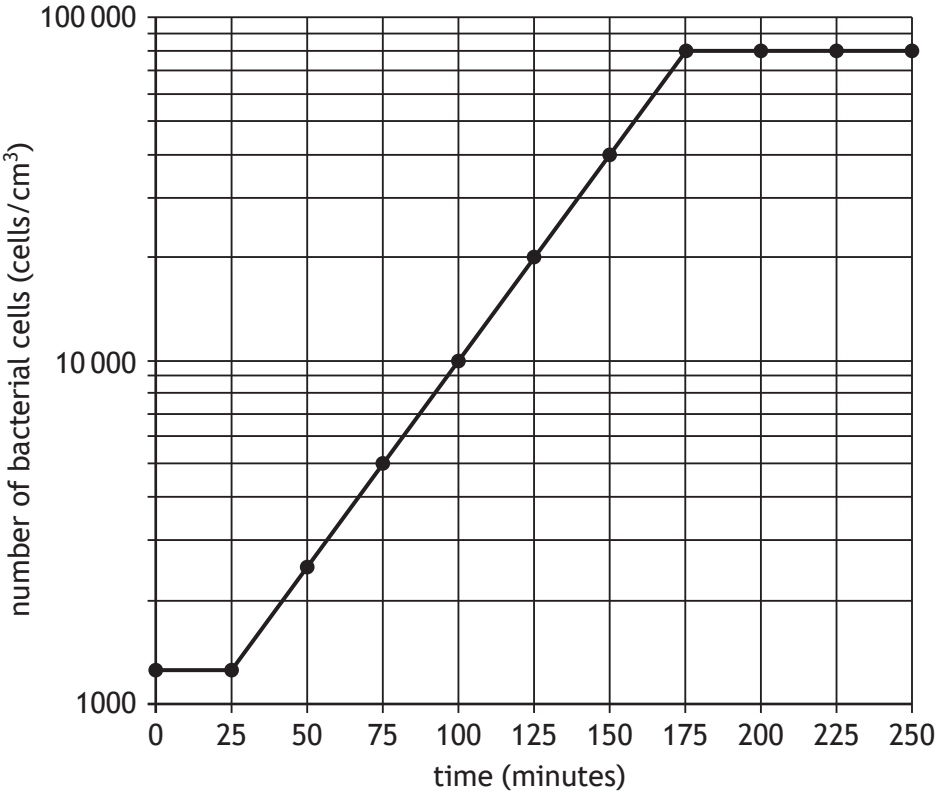
DO NOT WRITE IN THIS MARGIN

7. Some species of bacteria can be grown in fermenters to produce vinegar. The bacteria convert ethanol in the growth medium into vinegar.

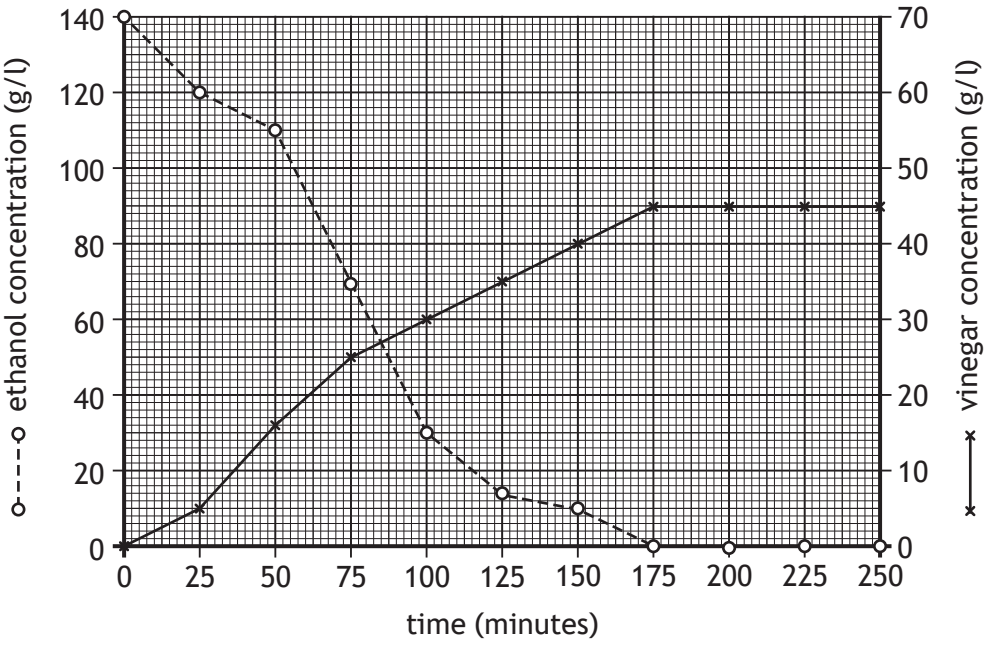
An investigation was carried out to determine the relationship between the number of bacterial cells and the concentrations of ethanol and vinegar over 250 minutes.

The results are shown in **Graph 1** and **Graph 2**.

Graph 1



Graph 2



7. (continued)

(a) **Using information in Graph 1** state the duration of the log phase. **1**

_____ minutes

(b) (i) **Using values from Graph 2**, describe changes in the concentration of vinegar over the time of the investigation. **2**

_____

_____

_____

_____

(ii) **Using information from Graph 2**, identify the time when ethanol concentration equals vinegar concentration. **1**

_____ minutes

(c) **Using information from Graph 2**, explain why there is no further increase in vinegar concentration after 175 minutes. **1**

_____

_____

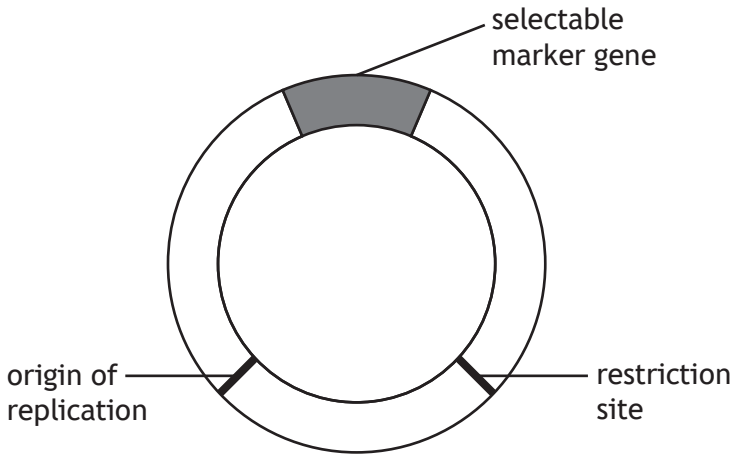
(d) **Using information from Graph 1 and Graph 2**, identify the concentration of vinegar when the number of bacteria is 40 000 cells per cm^3. **1**

_____ g/l

[Turn over

8. Recombinant DNA technology involves the use of plasmids to transfer desired genes into microbial cells.

The diagram shows some key features of a plasmid used in recombinant DNA technology.



(a) (i) State the term used to describe the role of the plasmid in recombinant DNA technology. **1**

_____

(ii) Describe the function of the origin of replication. **1**

_____

_____

(b) Name the type of enzyme used to remove a desired gene from a chromosome and cut open the plasmid. **1**

_____

(c) When bacteria take up recombinant plasmids they are said to be transformed.

The selectable marker gene on the plasmid allows transformed bacteria to be identified.

Give an example of a selectable marker gene and explain how it allows transformed bacteria to be identified. **2**

Selectable marker gene _____

Explanation _____

_____

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

A Write notes on the circulatory system and heart chambers of mammals. **4**

OR

B Write notes on fermentation in plants and yeast. **4**

You may use labelled diagrams where appropriate.

[Turn over

DO NOT WRITE IN THIS MARGIN

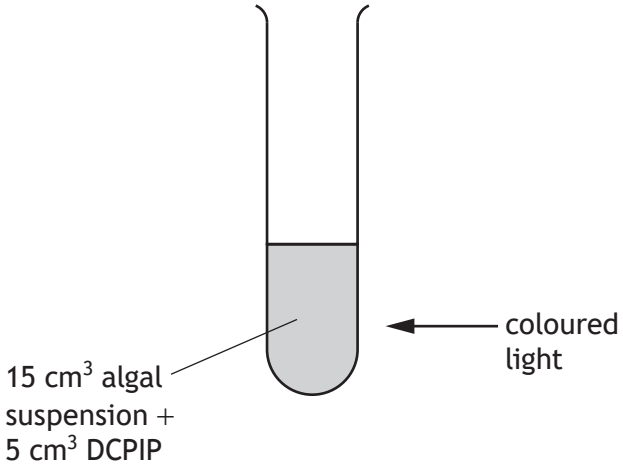
10. DCPIP can be used to measure the rate of photolysis.

It changes from blue to colourless when it gains hydrogen ions produced from the splitting of water.

DCPIP (blue) + hydrogen ions ⟶ DCPIPH (colourless)

An investigation was carried out to determine the colour of light that resulted in the highest rate of photolysis in algal cells.

Algal cells were mixed with DCPIP in a test tube and exposed to different colours of light as shown in the diagram.



The apparatus was placed in a dark room and exposed to green light. The absorbance of the solution was measured every 40 seconds for 200 seconds using a colorimeter. The lower the absorbance, the higher the rate of photolysis.

The whole experiment was then repeated using red light then blue light.

The results are shown in the table.

	Absorbance (units)		
Time (seconds)	**Green light**	**Red light**	**Blue light**
0	1.45	1.45	1.45
40	1.46	1.36	1.28
80	1.46	1.22	1.12
120	1.44	1.08	0.96
160	1.45	0.96	0.82
200	1.44	0.88	0.74

10. (continued)

(a) (i) Identify the dependent variable in this investigation. **1**

(ii) Suggest why the investigation was carried out in a dark room. **1**

(b) On the grid, complete the line graph to show the results for the blue light.
The results for the green light and red light are shown on the grid.
(Additional graph paper, if required, can be found on *page 28*.) **2**

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

(d) Suggest why the absorbance values shown in the table remained high when algal cells were exposed to green light. **2**

11. Strawberries are commercially grown in Scotland under polytunnels with open ends to allow air to flow through.

(a) The yield of strawberries is often decreased by leaf-eating insects.

(i) Explain why the presence of leaf-eating insects decreases the yield of strawberries. **2**

(ii) Describe how biological control can be used to reduce infestations of leaf-eating insects. **1**

(iii) Describe a risk of using biological control. **1**

(iv) Control of insect pests can be more successful when integrated pest management is used.

Describe this approach. **1**

11. (continued)

(b) Strawberries can be affected by disease caused by the *Botrytis* fungus. The fungus causes a grey mould to grow on the strawberries in humid conditions.

(i) Suggest how the design of the polytunnel limits the spread of the fungal disease caused by *Botrytis*. **1**

(ii) Applications of fungicides to control *Botrytis* are often based on disease forecast.

State a benefit of applying fungicides based on a disease forecast. **1**

(c) Commercial strawberry plants are F_1 hybrids, which often have improved resistance to *Botrytis*.

(i) Other than improved disease resistance, give one other advantage of F_1 hybrids. **1**

(ii) State why F_1 hybrids are **not** usually bred together to produce more strawberry plants. **1**

[Turn over

12. Cane toads are native to Central America. They were introduced to Northern Australia to prey on beetles that are pests of sugar cane crops. The toads quickly became established over much of Australia.

(a) State the name given to introduced species that have become established in wild communities. **1**

_____

(b) The cane toad has become an invasive species in some areas of Australia.

What is meant by the term invasive species? **1**

_____

_____

(c) The Australian cane toad population has increased more than would have been expected in its native habitat.

Give one reason to explain why this has happened. **1**

_____

_____

12. (continued)

(d) A study was carried out to analyse the effect of the appearance of cane toads around a lake on the numbers of native frogs.

Cane toads were first detected around the lake in August. The numbers of native frogs and cane toads were recorded at different distances from the lake in August and then in December.

The results are shown in the table.

Distance from lake (m)	Number of native frogs		Number of cane toads	
	August	December	August	December
0	273	8	3	147
20	160	8	12	128
40	23	87	7	12
60	8	245	2	8

(i) Calculate the percentage decrease in native frog numbers at 20 metres from the lake between August and December. **1**

Space for calculation

_____ %

(ii) Describe the overall changes in numbers of native frogs and cane toads around the lake between August and December. **2**

Native frogs _____

_____

_____

Cane toads _____

_____

_____

13. Pigs are often intensively farmed, which may affect their welfare. The behaviour of a group of four pigs from one farm (Group A) was compared to the behaviour of a group of four pigs from another farm (Group B). The time each group spent feeding and the time spent in misdirected behaviour was recorded over a one-hour period.

The results are shown in the table.

Group	Average time spent feeding (minutes)	Average time spent in misdirected behaviour (minutes)
A	12.4	43.4
B	21.5	11.8

(a) (i) Express, as the simplest whole number ratio, the time spent feeding to the time spent in misdirected behaviour in Group A. **1**

Space for calculation

_____ : _____
feeding misdirected behaviour

(ii) Identify the group in which animal welfare was poorer and justify your answer. **1**

Group _____

Justification _____

_____

(b) Suggest how this study could be modified to increase the reliability of the results. **1**

_____

_____

(c) Give another behavioural indicator of poor animal welfare not already mentioned. **1**

_____

13. (continued)

(d) Give one reason why intensive farming is often used instead of free range farming. **1**

(e) Livestock are fed cereal crops such as barley and wheat.

Explain how food security would be increased if humans ate more cereal crops instead of eating meat. **2**

[Turn over

14. (a) Lions live in groups called prides. Co-operative hunting by a pride of **10** lions was investigated over a period of time.

The prey species, number of hunts and percentage of successful hunts by the pride is shown in the table.

Prey species	Number of hunts	Successful hunts (%)
Zebra	60	30
Impala	80	20
Wildebeest	30	40

(i) One impala provides an average of 221 000 kJ of energy.

Calculate the average energy obtained by **one** lion from the impala prey during this period. **1**

Space for calculation

_____ kJ

(ii) State an advantage of co-operative hunting. **1**

_____

_____

(b) Lions living in a pride is an example of a social hierarchy.

(i) Describe what is meant by social hierarchy. **2**

_____

_____

(ii) Name a type of behaviour shown by animals living in a social hierarchy which reduces conflict. **1**

_____

(iii) Other than reducing conflict, give an advantage of living in a social hierarchy. **1**

_____

_____

MARKS | DO NOT WRITE IN THIS MARGIN

15. Attempt **either A or B**. Write your answer in the space below and on *pages 26* and *27*.

A Write notes on DNA replication. **8**

OR

B Write notes on speciation. **8**

You may use labelled diagrams where appropriate.

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWER to question 15

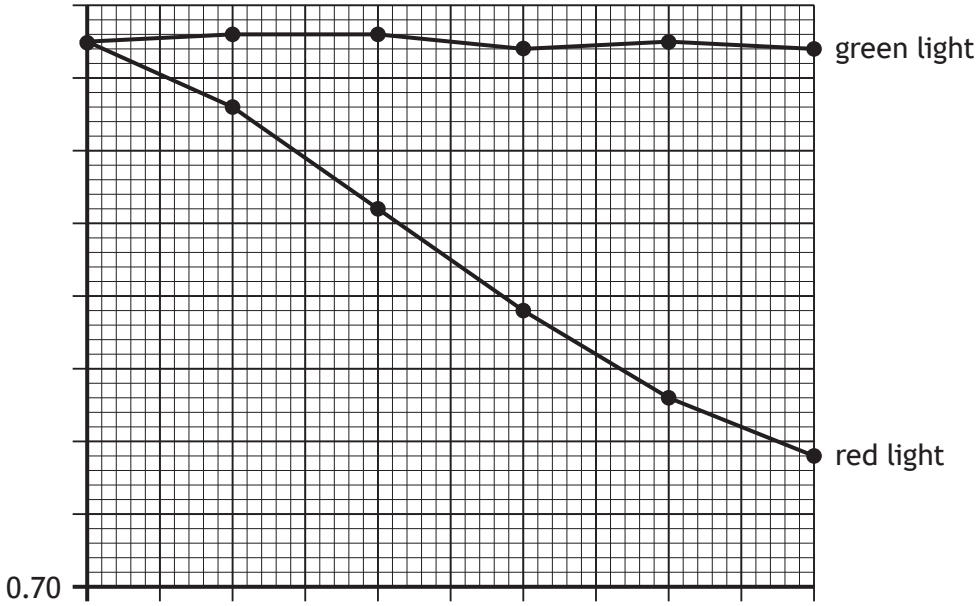
MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWER to question 15

[END OF QUESTION PAPER]

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph paper for question 10 (b)



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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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