Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Biology A (Salters Nuffield)

Advanced

Paper 1: The Natural Environment and Species Survival

Sample Assessment Material for first teaching September 2015

Time: 2 hours

Paper Reference

9BN0/01

You may need a ruler, a pencil and a calculator.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Show your working in any calculation questions and include units in your answer where appropriate.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- You may use a scientific calculator.
- In questions marked with an asterisk (*****), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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S 4 7 5 6 3 A 0 1 3 6

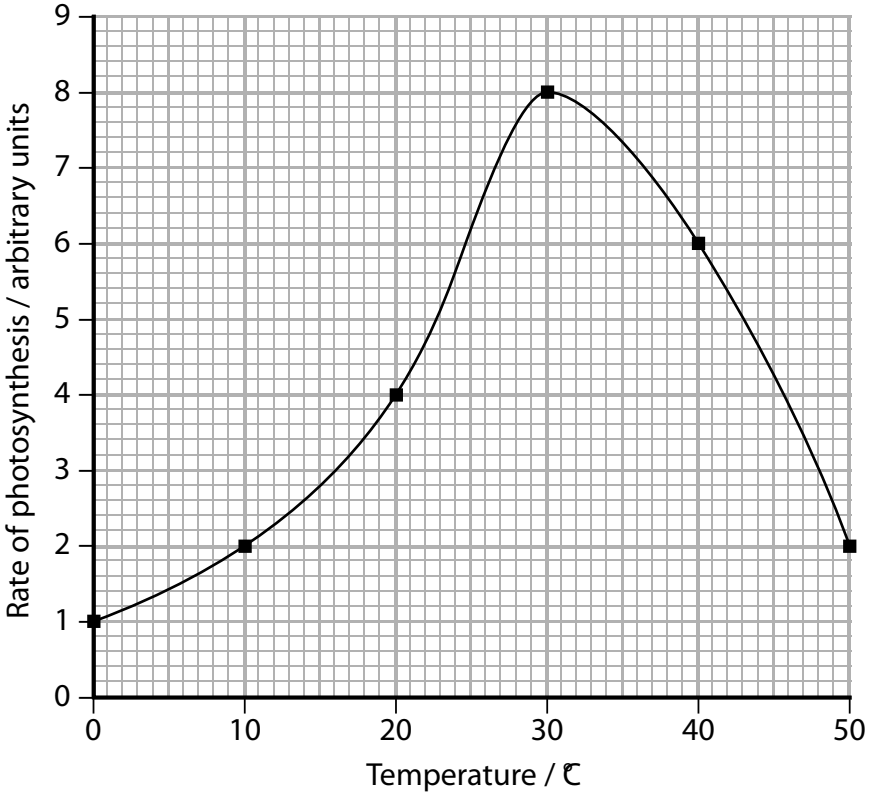
PEARSON

Answer ALL questions.

Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 The reactions involved in photosynthesis are affected by environmental factors.
The graph shows the effect of temperature on the rate of photosynthesis in wheat.



(a) Calculate the Q_{10} for photosynthesis between 20 °C and 30 °C.

(1)

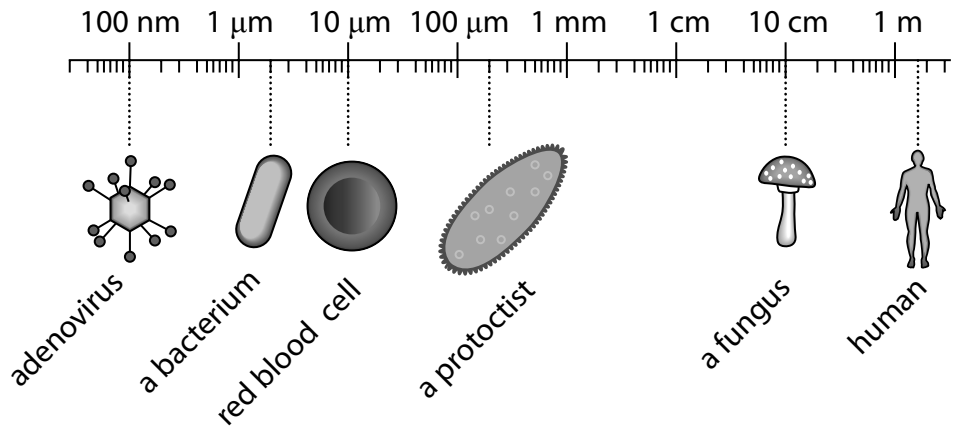
Answer.....

(b) Explain the effect of temperature on the rate of photosynthesis in wheat.

(3)

(Total for Question 1 = 4 marks)

2 The diagram compares the size of some microbes with that of a human and a human cell.



(a) Which of the following belong to the domain Eukaryota?

(1)

- ☒ **A** adenovirus, bacterium and protoctist
- ☒ **B** human, bacterium and red blood cell
- ☒ **C** human, red blood cell and protoctist
- ☒ **D** adenovirus, fungus and human

(b) Which of the following do **not** have a nucleus?

(1)

- ☒ **A** bacterium and protoctist
- ☒ **B** bacterium and red blood cell
- ☒ **C** fungus and adenovirus
- ☒ **D** protoctist and adenovirus

(c) Which of the following shows how many times bigger the bacterium is than the adenovirus?

(1)

☒ **A** 45 times

☒ **B** 22 times

☒ **C** 2 times

☒ **D** 10 times

(d) State **one** way in which the structure of a virus is different from that of a bacterium.

(1)

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(Total for Question 2 = 4 marks)

3 A new species of mosquito has evolved in the tunnels of the London Underground. These mosquitoes are believed to be the descendants of bird-biting mosquitoes which colonised the tunnels 100 hundred years ago. The mosquitoes now feed on rats, mice and human beings instead of birds.

(a) Place a cross in the box next to the best definition of a species.

(1)

☒ **A** individuals can interbreed to produce fertile offspring

☒ **B** individuals can interbreed to produce hybrid offspring

☒ **C** individuals can interbreed to produce sterile offspring

☒ **D** individuals can interbreed to produce offspring

(b) Explain how this species of mosquito may have evolved.

(5)

(Total for Question 3 = 6 marks)

4 In the 18th century, William Withering trialled the use of an extract of foxglove plants to treat a heart condition.

(a) Give **four** reasons why a contemporary drug testing protocol is an improvement on the trial used by William Withering.

(4)

(b) In a drug trial, people with a heart condition were given one of three drug treatments. The table shows the recorded improvement in their condition for each of the three treatments.

Treatment	Concentration of drug / mg	Recorded improvement / arbitrary units
1	0	18.8
2	400	24.8
3	600	30.9

It was concluded that the drug treatment improved the condition of the patients.

Analyse the data to comment on this conclusion.

(3)

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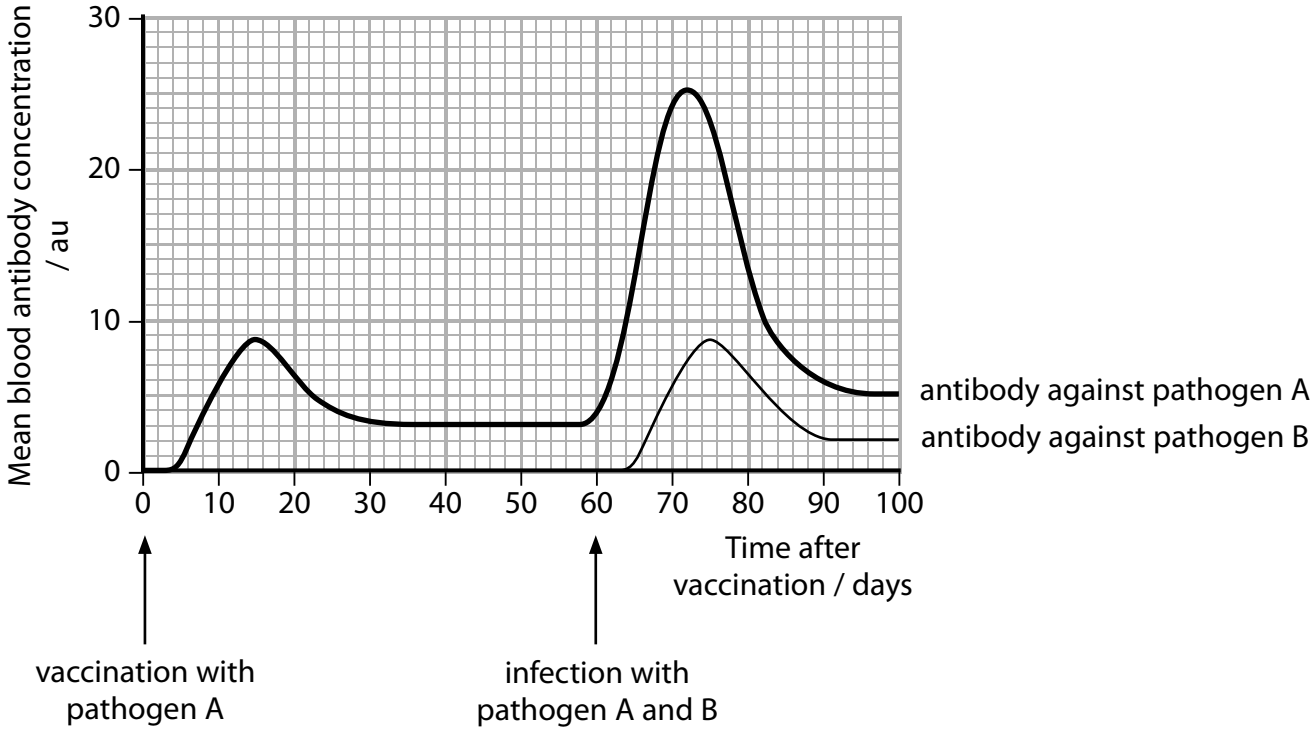
(Total for Question 4 = 7 marks)

5 Many people have a vaccination before visiting some countries for the first time.

A person was vaccinated with a weakened form of pathogen six weeks before travelling to a particular country. The person was infected by two different pathogens, A and B, when in this country.

The graph shows what happened to different blood antibody concentrations of the person after vaccination and after infection by the two different pathogens.



(a) The changes to blood antibody concentration occur because vaccination produces

(1)

☒ **A** active artificial immunity

☒ **B** active natural immunity

☒ **C** passive artificial immunity

☒ **D** passive active immunity

(b) Explain why this person did not become ill from pathogen A but did become ill from pathogen B when visiting this country.

(6)

(Total for Question 5 = 7 marks)

6 The photograph shows heather, *Calluna vulgaris*, a plant that grows on moorland.

In an investigation into the net primary productivity of heather, all the vegetation on an area of two different moorlands, A and B, was removed by burning. The dry biomass, in g m^{-2}, was then measured each year for a period of 20 years.

(a) Give an equation that shows the relationship between gross primary productivity, net primary productivity and respiration.

(1)

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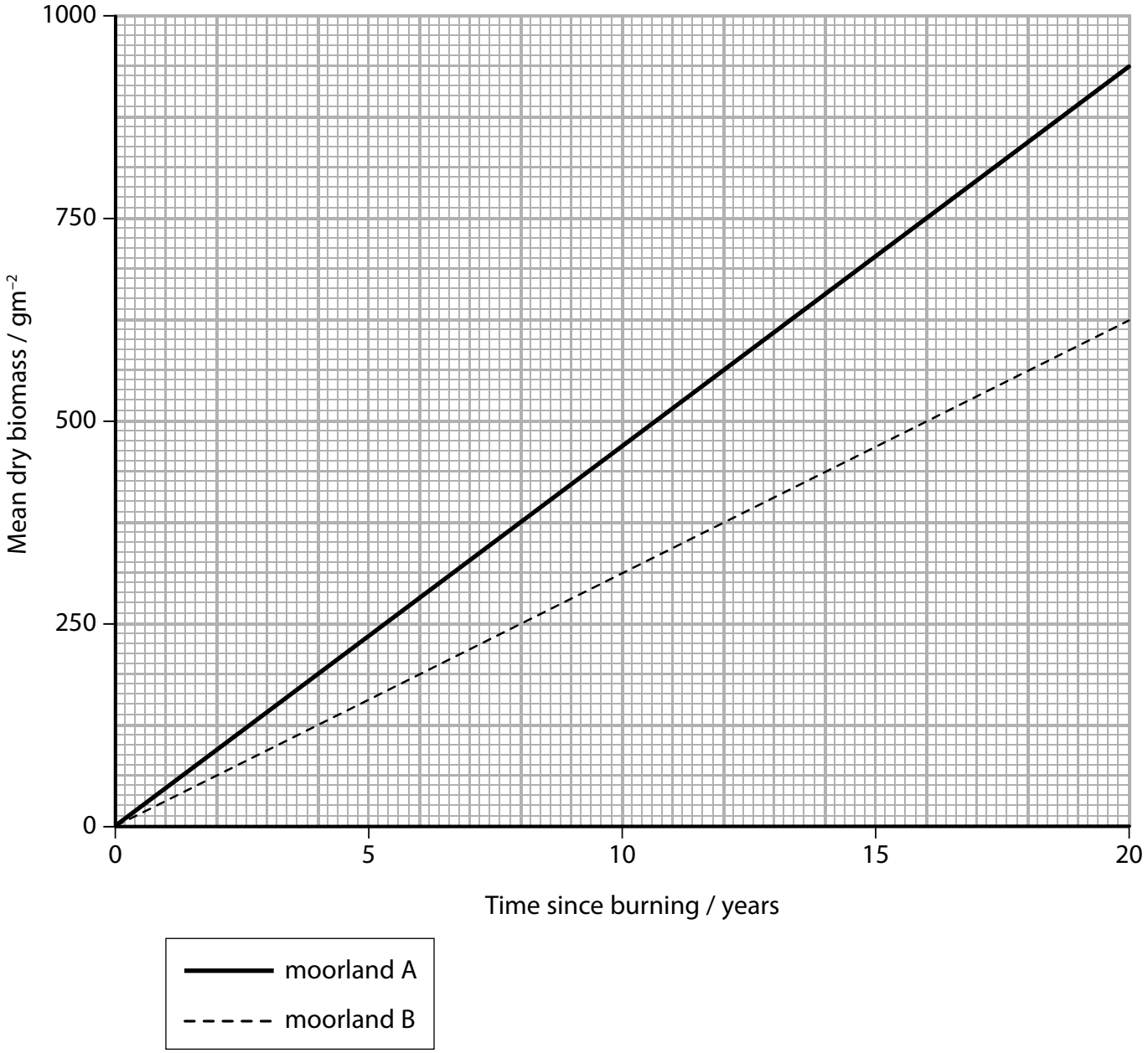
(b) The graph shows the change in the mean dry biomass of the heather plants during the 20 year period.



(i) Describe a method that could be used to obtain the mean dry biomass of the heather plants in year 20.

(2)

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(ii) The total solar radiation reaching moorland A was 3 144 000 kJ m^{-2} yr^{-1}.
Each gram of dry heather contains 22.186 kJ.

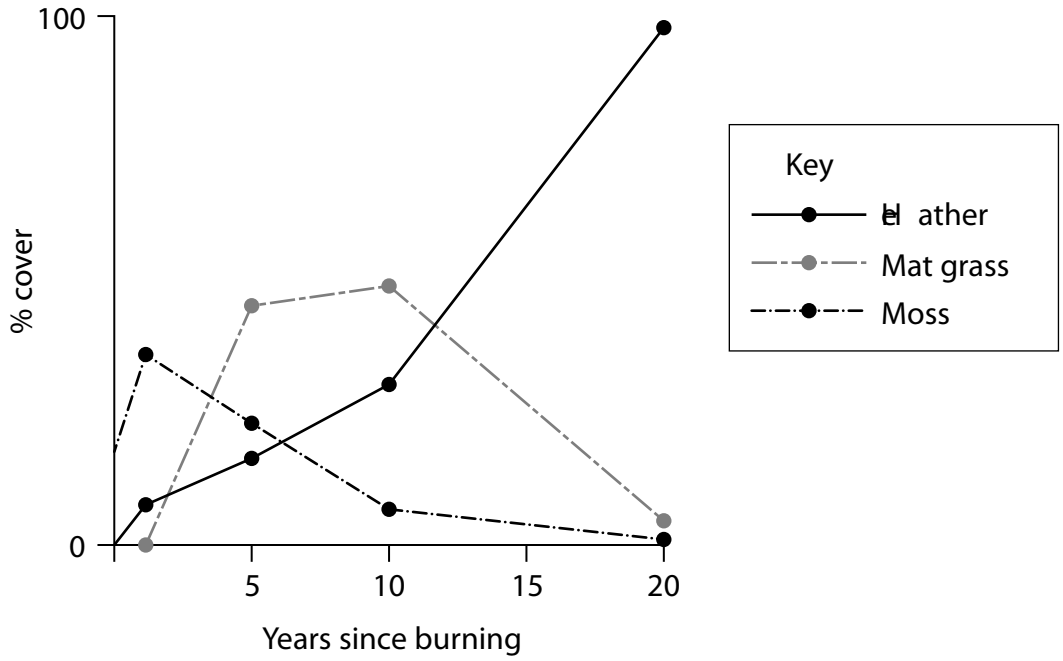
Calculate the percentage efficiency of heather plants from moorland **A** at converting solar radiation into dry biomass.

(2)

Answer.....

(iii) After the burning of the moorland, a process of succession occurred.

The following information shows some of the changes found over the 20 years.



Analyse the data to explain the changes shown.

(3)

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(Total for Question 6 = 8 marks)

7 Researchers carried out a study on the prey of predatory ground beetles. They removed the contents of the guts of beetles which had been feeding and analysed them to see if they could identify the species they had fed on.

In one study, to see if the method worked, they fed the beetles on earthworms of the species *Allolobophora chlorotica* only.

DNA was extracted from the gut contents and analysed.

(a) The quantity of worm DNA in the beetle gut was very small.

Describe how sufficient DNA was produced to carry out the analysis.

(3)

(b) (i) The DNA in the samples from the beetle guts was cut into fragments. The fragments were different for each species and had to be separated by gel electrophoresis.

Which of the following describes the movement of the DNA fragments in gel electrophoresis?

(1)

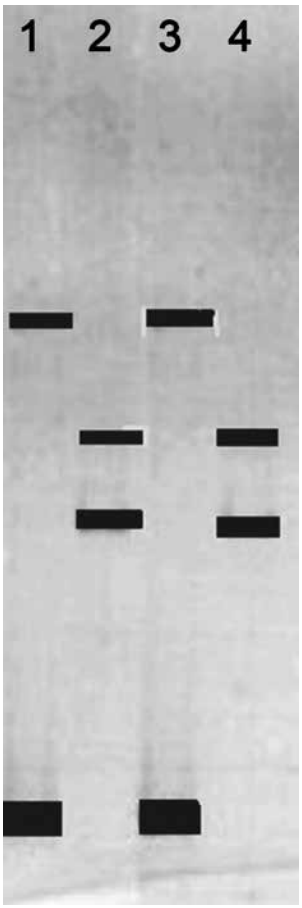
☒ **A** large fragments move further than small fragments towards the anode

☒ **B** large fragments move further than small fragments towards the cathode

☒ **C** small fragments move further than large fragments towards the anode

☒ **D** small fragments move further than large fragments towards the cathode

(ii) The picture shows one set of results in which four samples have been separated.



(Source: Evaluation of temperature gradient gel electrophoresis for the analysis of prey DNA within the guts of invertebrate Sheppard et al. Cardiff School of Biosciences)

Explain what these results show you about the diet of the ground beetles.

(2)

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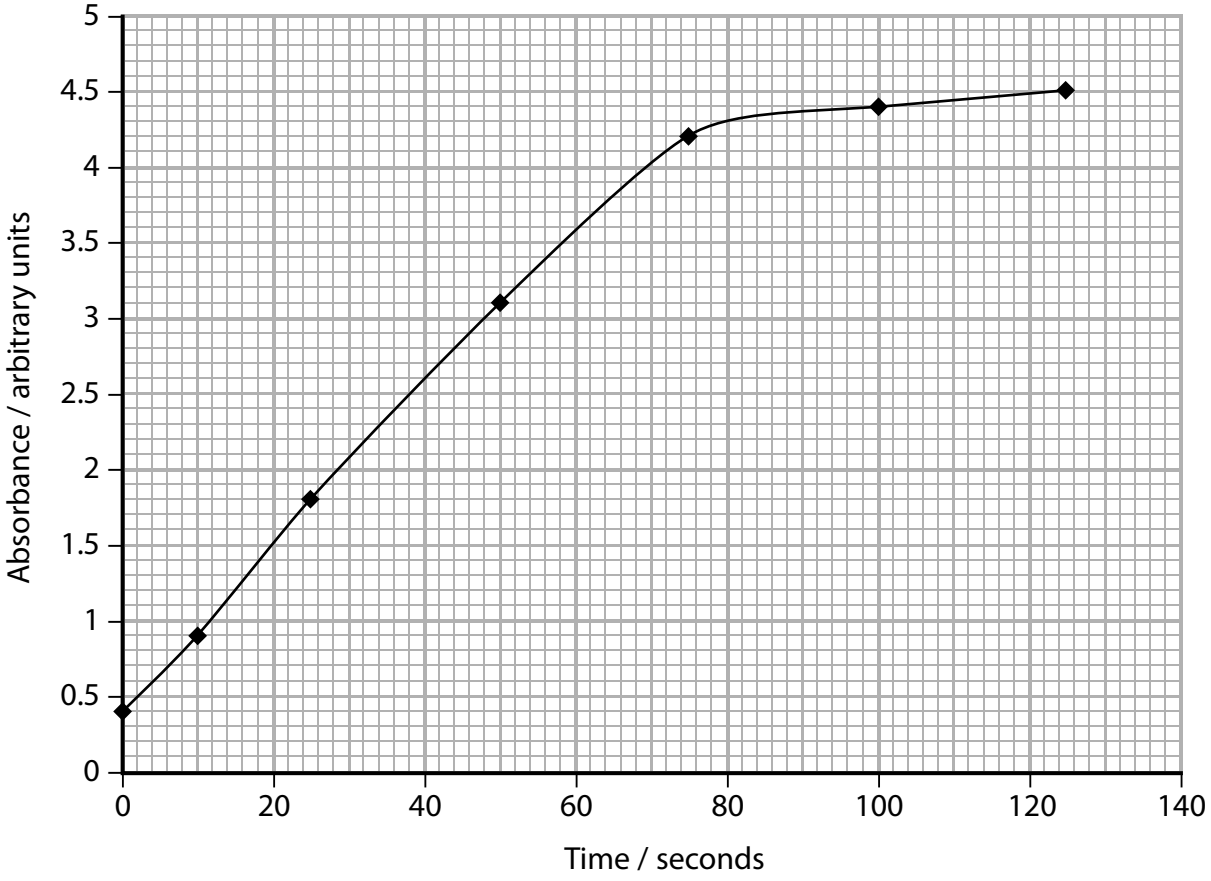
(Total for Question 7 = 6 marks)

8 L-dopa forms a colourless solution in water. Dopa oxidase is an enzyme that converts L-dopa into dopachrome, which is red.

A colorimeter can be used to study this reaction. As the red colour appears, the amount of light absorbed by the solution increases.

(a) The graph shows the course of a reaction in which there was an enzyme concentration of 20 (arbitrary units) of reaction mixture.



Calculate the initial rate of reaction for this concentration of enzyme.

(3)

Answer .....

(b) In another study, a student used this procedure with a range of enzyme concentrations. The results are shown in the table below.

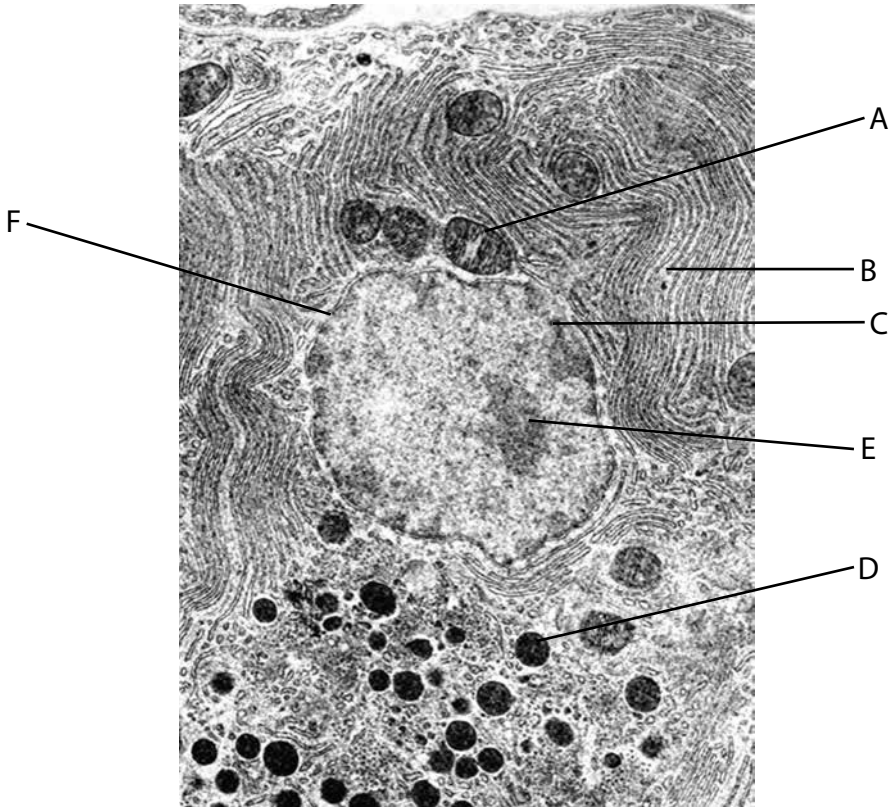
Enzyme concentration / arbitrary units	Initial rate of reaction / absorbance s^{-1}
0	0.0
10	2.5
30	6.1
50	9.0
70	11.0
90	11.0

Explain the effect of enzyme concentration on the initial rate of this reaction.

(3)

(c) Enzymes are made, modified, stored and used in cells.

The photograph shows an electron micrograph of a cell from the pancreas.



(i) Which structure in the photograph uses enzymes in respiration?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(ii) Which structure in the photograph is the nucleolus?

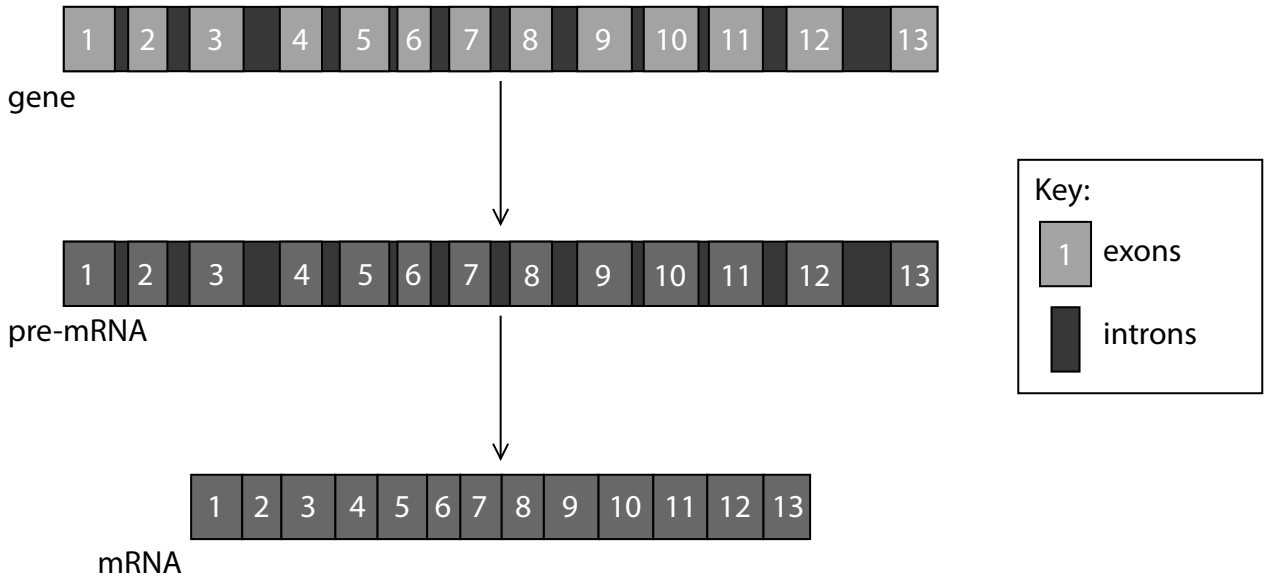
(1)

- ☒ **B**
- ☒ **C**
- ☒ **E**
- ☒ **F**

(Total for Question 8 = 8 marks)

9 A central idea in biology is that DNA codes for the synthesis of proteins from amino acids. The instructions for making proteins are in the form of mRNA.

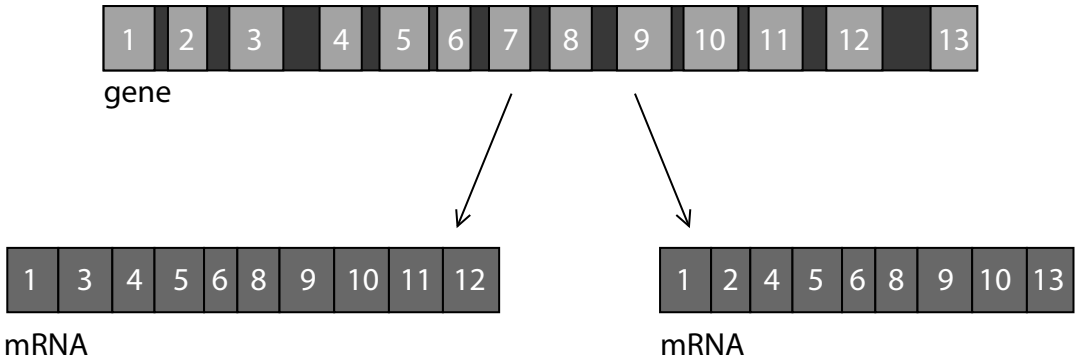
The diagram shows two stages in the production of mRNA.



(a) Explain how this molecule of mRNA is produced.

(4)

(b) Sometimes the process is more complicated as shown in the diagram below.



An initial estimate of the number of genes, based on the number of proteins found in humans, was in the region of 100 000. It is now known that the number of genes is around 25 000.

Explain how the formation of mRNA, shown in the diagram, might account for this.

(5)

(Total for Question 9 = 9 marks)

10 A student investigated the light-dependent reactions of photosynthesis in spinach leaves.

The leaves were cut into pieces and ground in a cold solution of sucrose and a buffer.

The mixture was filtered and centrifuged. The liquid in the tube was poured off and kept in an ice water bath.

The pellet at the bottom of the tube was suspended by mixing with fresh sucrose and buffer and stored in an ice water bath.

Four tubes were then set up as follows:

Tube	Liquid poured off after centrifuging / cm^3	Resuspended pellet / cm^3	Sucrose and buffer solution / cm^3
1	–	0.5	–
2	–	–	0.5
3	–	0.5	–
4	0.5	–	–

The tubes had 5 cm^3 of DCPIP added to them. Tube 3 was kept in the dark and the others kept in the light.

After twenty minutes, the colour in each tube was recorded. The results are shown in the table below.

Tube	Colour in tube
1	pale green
2	blue
3	blue
4	blue

(a) (i) Give **two** reasons why a cold solution containing sucrose and a buffer was used in this investigation.

(2)

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(ii) Give a reason why tube 3 was used in this investigation.

(1)

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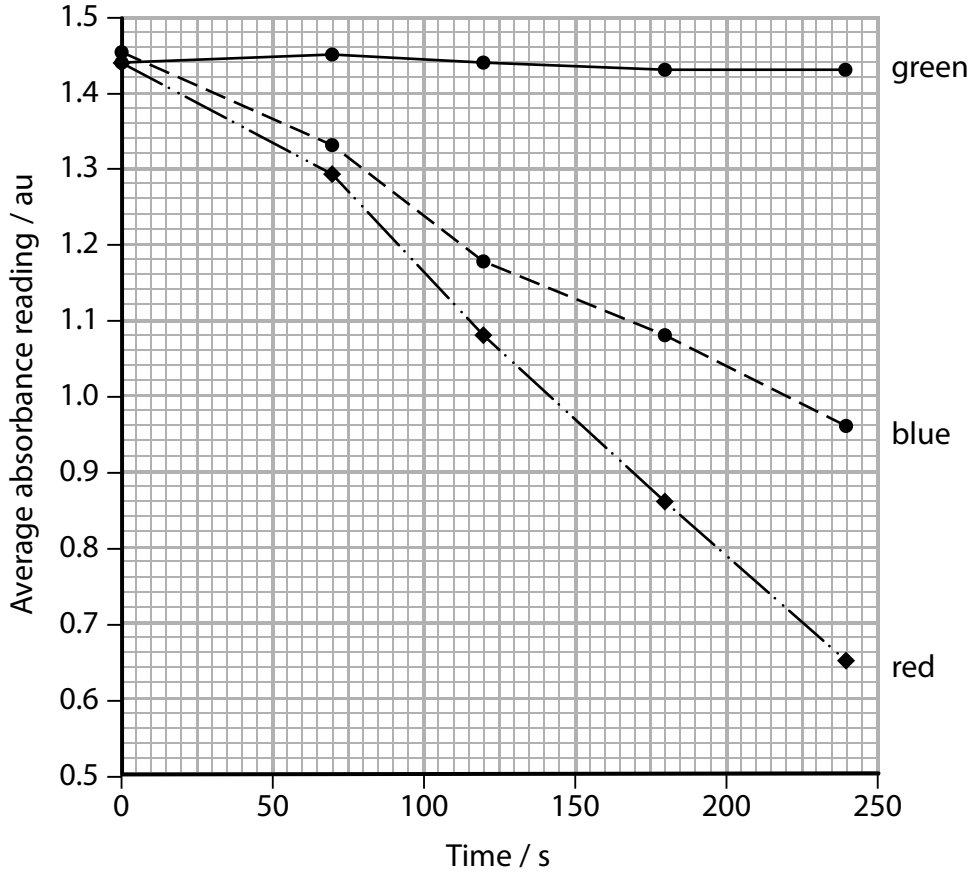
(iii) In another investigation, the student wanted to determine the effect of different wavelengths of light on the light-dependent stage of photosynthesis.

The student modified her first investigation to obtain results.

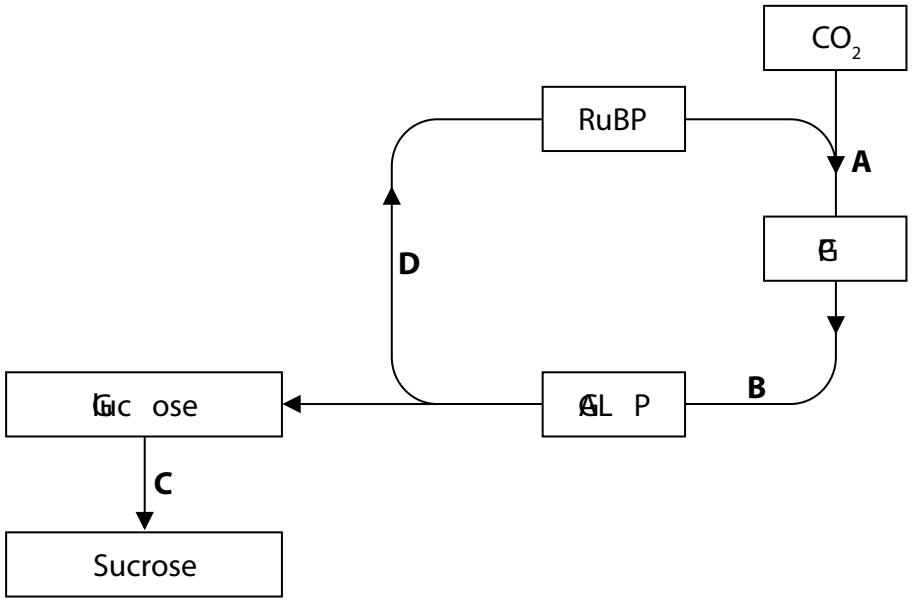
The graph shows the results of her modified investigation.



Explain how the student modified the practical procedure of the first investigation to enable these results to be obtained.

(4)

(b) The diagram shows part of the Calvin cycle (light-independent reactions) of photosynthesis.



Place a cross in the box which indicates the correct stage (A – D) for the following statements.

(i) The stage which involves a condensation reaction and fructose.

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(ii) The stage where the enzyme RUBISCO is involved.

(1)

☒ **A**

☒ **B**

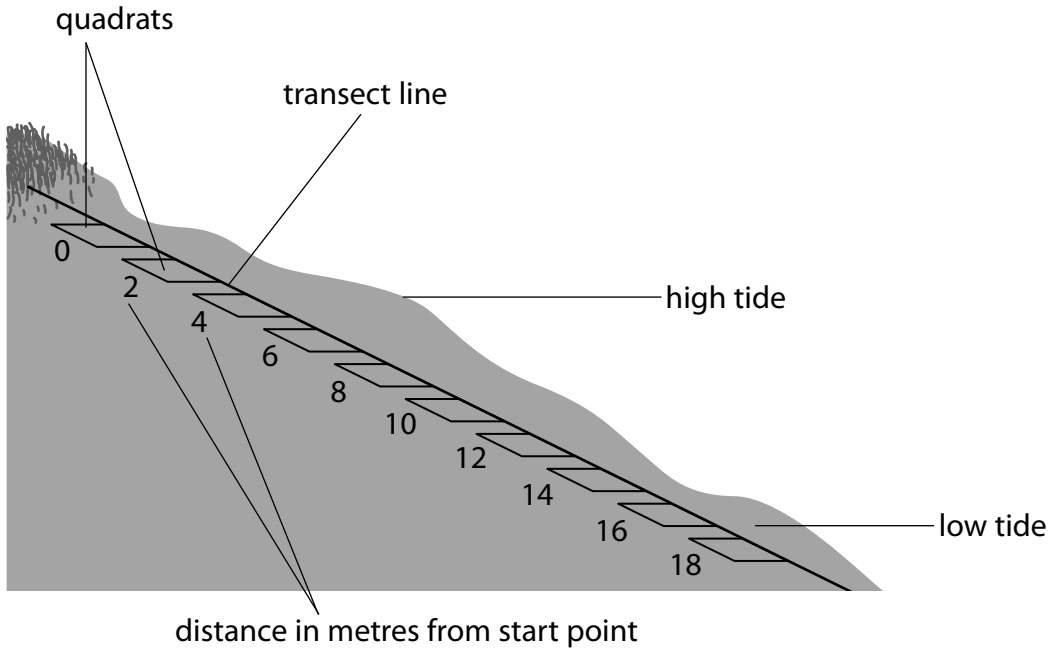
☒ **C**

☒ **D**

(Total for Question 10 = 9 marks)

11 The distribution and abundance of species on a rocky shore were investigated using a systematic sampling technique.

(a) The diagram shows the placing of the transect and quadrats on a rocky shore.



Not to scale

(i) Give a reason why systematic sampling, rather than random sampling, was used in this investigation.

(1)

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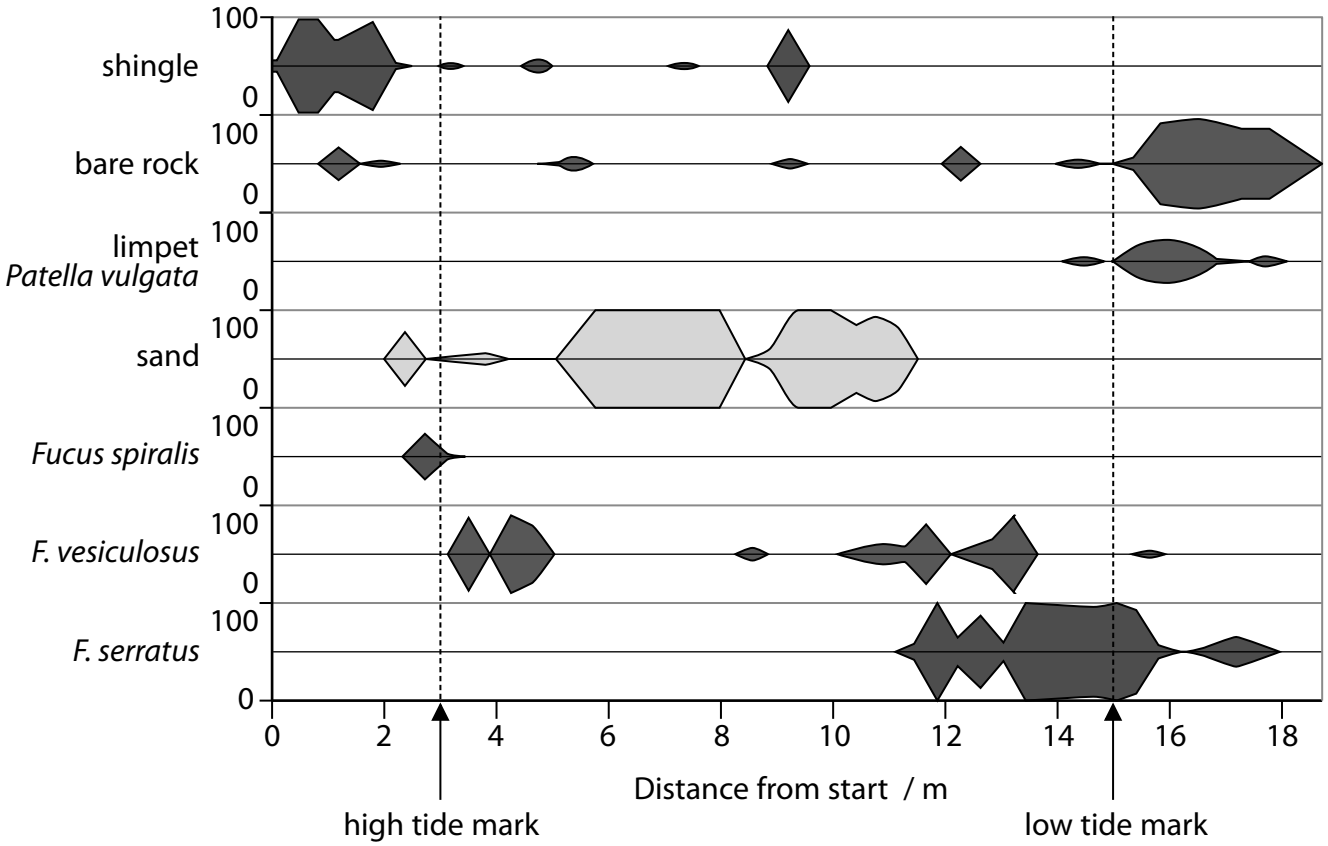
(ii) The diagram shows the distribution of some of the abiotic and biotic components of a sea shore. There are three species of seaweed (*Fucus*) and one species of limpet (*Patella vulgata*). Limpets feed on seaweed.



Analyse the data to explain how the distribution patterns of *Fucus spiralis, Fucus vesiculosus* and *Fucus serratus* are affected by abiotic and biotic factors.

(6)

(b) (i) Another study compared the diversity of species at different places on the shore. On the upper shore the following data were obtained.

Species	Number of individuals found
Pelvetia canaliculata	10
Enteromorpha sp.	3
Patella vulgata	3
Littorina littorea	15
Gibbula sp.	14
Lichens	15

Calculate an index of diversity (D) for this site using the formula below.

(3)

$$D = \frac{N(N-1)}{\Sigma n(n-1)}$$

n = total number of organisms of a particular species

N = total number of organisms of all species

Answer .....

(ii) On the middle shore the index was found to be 7.74 with a total individual count of 37.

Comment on the relationship between diversity and the total number of individuals on these two parts of the shore.

(2)

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(Total for Question 11 = 12 marks)

12 A student carried out an investigation to compare the antibacterial effect of a garlic extract with that of three antibiotics, all at the same concentration.

(a) (i) To obtain the extract, a clove of garlic was cut into lots of small pieces and soaked in 0.1% ethanol for a long time.

Explain why this is an effective method of extraction.

(2)

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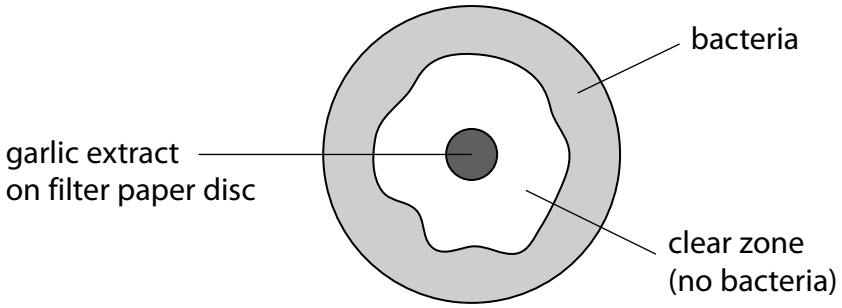
(ii) The diagram shows the effect of the garlic extract on bacteria growing on an agar plate.



The area of the clear zone was calculated by assuming it is a circle and estimating the diameter. The estimate made was 4.3 cm.

Calculate the estimated area of the clear zone.

(2)

Answer .....

(b) The results of the investigation are shown in the table.

Sample number	Estimated area of clear zone / mm²			
	Antibiotics			Plant extract
	Chloramphenicol	Tetracycline	Streptomycin	Garlic
1	28	16	15	20
2	26	19	13	28
3	29	11	14	18
4	28	21	12	25
5	26	7	14	27
6	29	11	15	26
7	22	8	9	25
8	25	21	14	25
9	29	10	12	29
Mean	27	14	13	25
Standard deviation	2.37	5.54	1.90	3.60

These data were analysed using *t*-tests.

(i) Several statistical tests were available to the student to analyse these data, including the *t*-test, Chi squared and the correlation coefficient.

Explain why the *t*-test was chosen to analyse these data, rather than the other two tests.

(3)

(ii) Calculate the *t* value for the data to compare garlic with chloramphenicol, using the formula:

$$t = \frac{\left|\overline{x}^1 - \overline{x}^2\right|}{\sqrt{\left(\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}\right)}}$$

(3)

Answer .....

(iii) The table shows the critical values of *t* with 16 degrees of freedom.

Significance level (p)	0.20	0.10	0.05	0.01	0.001
Critical value of *t*	1.34	1.75	2.12	2.92	4.02

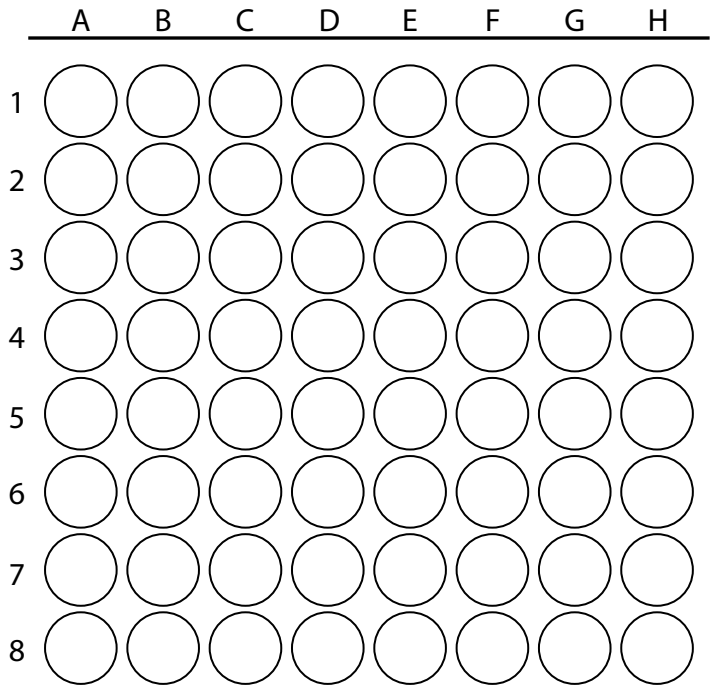
Use your value of *t* to test the validity of a stated null hypothesis.

(4)

(c) The size of the clear zone depends on variables other than the antibacterial properties of the substances used, such as size and solubility of the antimicrobial molecules in the extract.

A new method was developed in which the minimum concentration of extract that causes inhibition of bacterial growth (Minimum Inhibitory Concentration, MIC), was found.

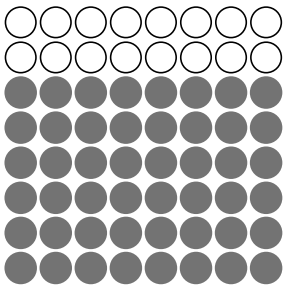
Samples of extract, bacteria (*E. coli*) and a respiration indicator were placed in a micro-titre tray.



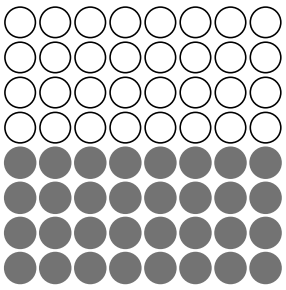
1 = 4%
2 = 2%
3 = 1%
4 = 0.5%
5 = 0.25%
6 = 0.125%
7 = 0.0625%
8 = 0.0%

concentration of extract

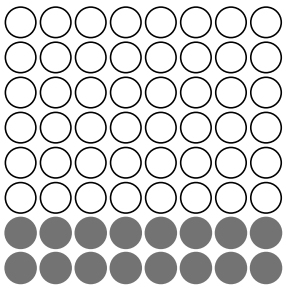
The diagrams show the results obtained. The tubes are black when respiration occurs and clear when no respiration occurs.



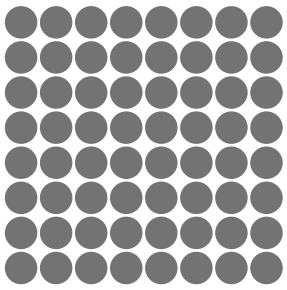
rosemary



geranium



garlic



cedar

(i) Analyse the data to explain the results of this experiment.

(2)

(ii) Give **two** changes that can be made to the procedure to get a more accurate measure of MIC.

(2)

(iii) It was concluded that plant extracts inhibit respiration of bacteria. This conclusion may not be valid because the investigation has limitations.

Describe how the investigation could be modified to reduce the effect of two named limitations.

(2)

(Total for Question 12 = 20 marks)

TOTAL FOR PAPER = 100 MARKS

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