

BIOLOGY NUMERACY EXAM QUESTIONS BOOKLET



Centre Number		12416	
Candidate Number			
Candidate forename		Candidate surname	
Class			
Teachers' initials			

Qu	Skill	Total Mark	Marks ach'd	Traffic Light
1 - 8	Standard form and unit conversions	21		
9 - 20	Percentages, ratios and fractions	25		
21 - 27	Order of magnitude	16		
28 - 34	Mean, median, mode and standard deviation	44		
35 - 39	Interpreting graphs	19		
40 - 44	Gradients, intercepts and tangents	9		
45 - 47	Probability	12		
48 - 52	Algebra	23		
53 - 55	surface areas and volumes of regular shapes	10		

*When completed circle or highlight the skills that you need to address in your revision.

Botulism is a condition resulting from the action of botulinum toxin. The main symptom of botulism is skeletal muscle weakness, which can be fatal.

- (a) (i) Botulinum toxin is produced by the anaerobic bacterium *Clostridium botulinum*.
What information does the word 'anaerobic' suggest about the bacterium?

.....
..... [1]

- (ii) The toxin is initially produced as a large single polypeptide that has low potency. After the toxin has been acted upon by a protease, two chains are produced which remain connected by a disulfide bond. In this form it is far more toxic.

Describe the action of the protease when it acts on the toxin.

.....
..... [1]

- (b) A mouse assay, using 99 mice, was used to determine the median lethal dose of the toxin.

- (i) Suggest what is meant by the term *median lethal dose*.

.....
..... [1]

- * (ii) The median lethal dose of the toxin is in the range of 5 – 50 ng kg⁻¹ body mass, depending on the toxin type and the method of introduction into the body.

Calculate the probable lethal dose of the **least toxic** botulinum toxin for an individual with a body mass of 85 kg.

Show your working and give your answer in µg.

Answer..... µg [2]

2 This Question is about ecosystems in the Southern (Antarctic) Ocean.

(a) Observe the food chain:

phytoplankton (producers) → krill (shrimps etc.) → small fish → large fish → seals

Table 21.1 shows the transfers of energy and the quantities of energy stored as biomasses for the food chain. Magnitudes are given in kilojoules per square metre of sea surface per year.

	Phyto-plankton	Krill	Small fish	Large fish	Seals
Energy input, by photosynthesis or feeding ($\text{kJ m}^{-2} \text{y}^{-1}$)	900	80	11	1.4	
Energy lost to surroundings by respiration ($\text{kJ m}^{-2} \text{y}^{-1}$)	180	64	8.8	1.2	1.05
Energy input converted to biomass ($\text{kJ m}^{-2} \text{y}^{-1}$)	720	16	2.2	0.2	0.05
Biomass energy lost to other consumers or decomposers ($\text{kJ m}^{-2} \text{y}^{-1}$)	640	5	0.8	0.09	0.05

Table 21.1

- * (i) For larger and less numerous organisms, such as the seal, it is more appropriate to record energy flows per square kilometre.

Calculate the energy input to the seal population from large fish. Record your answer in kilojoules per square kilometre of sea surface per year.

Answer..... [2]

- * (ii) Calculate the percentage of energy stored in large fish biomass converted to energy in seal biomass. Show your working.

Answer..... [2]

The efficiency with which the kidneys filter the blood can be measured by the rate at which they remove a substance called creatinine from the blood. The rate at which they filter the blood is called the glomerular filtration rate (GFR).

In 24 hours, a person excreted 1660 mg of creatinine in his urine. The concentration of creatinine in the blood entering his kidneys was constant at 0.01 mg cm^{-3} .

03.4 Calculate the GFR in $\text{cm}^3 \text{ minute}^{-1}$.

[1 mark]

Answer = _____

03.5 Creatinine is a breakdown product of creatine found in muscle tissues. Apart from age and gender, give **two** factors that could affect the concentration of creatinine in the blood.

[1 mark]

- 1 _____
- 2 _____

Turn over for the next question

0 4 3

The student counted the number of cells she observed in each stage of mitosis. Of the 200 cells she counted, only six were in anaphase.

One cell cycle of onion root tissue takes 16 hours. Calculate how many minutes these cells spend in anaphase.

Show your working.

[2 marks]

Answer = _____ minutes

Turn over for the next question

Questions

5

Peter goes for a walk.
He walks 15 miles in 6 hours.

(a) Work out Peter's average speed.
Give your answer in miles per hour.

..... mph
(2)

5 miles = 8 km.
Sunita says that Peter walked more than 20 km.

* (b) Is Sunita right?
You must show all your working.

(2)
(Total for Question is 4 marks)

6

*

Competition
a prize every 2014 seconds

In a competition, a prize is won every 2014 seconds.
Work out an estimate for the number of prizes won in 24 hours.

You must show your working.

•

(Total for Question is 4 marks)



(a) Work out the value of $\frac{\sqrt{30}}{2.5^2}$

Give your answer correct to 3 decimal places.

.....

(2)

(b) Change 4.5 km² to m².

.....m²
(2)

(Total for Question is 4 marks)



Dionne has 60 golf balls.
Each of these golf balls weighs 42 grams to the nearest gram.

Work out the greatest possible total weight of all 60 golf balls.
Give your answer in kilograms.

.....kg

(Total for Question is 3 marks)

09

1 Contrast the processes of facilitated diffusion and active transport.

[3 marks]

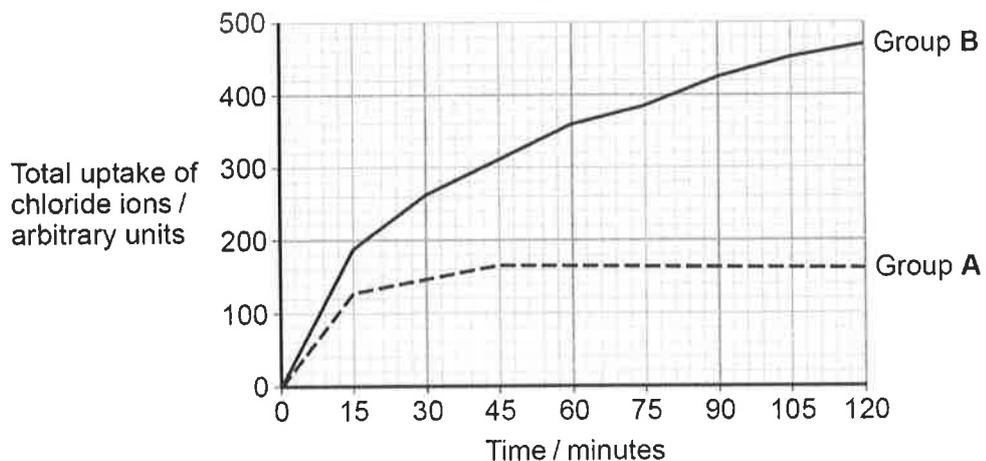
[Extra space]

Students investigated the uptake of chloride ions in barley plants. They divided the plants into two groups and placed their roots in solutions containing radioactive chloride ions.

- Group **A** plants had a substance that inhibited respiration added to the solution.
- Group **B** plants did not have the substance added to the solution.

The students calculated the total amount of chloride ions absorbed by the plants every 15 minutes. Their results are shown in **Figure 4**.

Figure 4



09

2 Calculate the ratio of the mean **rate** of uptake of chloride ions in the first hour to the **rate** of uptake of chloride ions in the second hour for group **B** plants.

[2 marks]

Ratio = _____ :1

09

3 Explain the results shown in **Figure 4**.

[4 marks]

[Extra space]

Questions



The scientific article you have studied is adapted from articles in The Biologist. Use the information from the article and your own knowledge to answer the following questions.

(a) Explain why obesity is 'a big problem' for society (paragraph 2). (2)

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(b) Describe the structure of triglyceride fat found in white adipose tissue (WAT). (2)

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~~X~~ (c) Calculate the percentage increase in deaths for young girls with anorexia (paragraph 6). (2)

Answer =%

(d) State the evidence supporting the idea that specific parts of the brain are responsible for the gender differences in the processing of information related to body image (paragraphs 8 to 14). (4)

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(e) Explain why the raised cortisol levels due to dieting in females, may be a long term risk factor (paragraph 18). (2)



Plant statins are used in the treatment of cardiovascular disease (CVD). Some fungi can produce chemicals that can be used as statins. One example is a chemical referred to as drug S. One study into the effect of drug S on the health of people taking it involved 20 000 people and ran for a period of 5 years. One group of people was given drug S and the other group was given a placebo. Each group had 10 000 people in it. The table below shows some of the findings from this study.

Event	Percentage of people (%)	
	Taking drug S	Taking the placebo
Death	12.9	14.7
CVD	8.7	11.8
Stroke	4.3	5.7

(a) (i) Name **two** factors that increase the risk of CVD.

(1)

1

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2

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(ii) Suggest why it was necessary to have so many people involved in this study.

(2)

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(b) Suggest what the placebo could be in this study.

(1)

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(c) Suggest why this study had to run for a number of years.

(1)

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(d) Using the data in the table, what is the evidence that drug S is safe for people to take?

(2)

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* (e) (i) Calculate how many more people given the placebo had CVD compared with those given drug S. (3)

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(ii) Explain why drug S could be a potential statin.

(1)

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(Total for question = 11 marks)



The skin has an important role in protecting the body from infection by pathogenic bacteria. Human skin has a community of microorganisms, called the skin flora, living on it. Most of these microorganisms are harmless bacteria that feed on dead skin cells and secretions.

(a) (i) State **two** ways in which the skin flora can help to protect a person from infection by pathogenic bacteria.

(2)

1

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2

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(ii) Place a cross next to the part of the skin that forms a physical barrier against infection by pathogenic bacteria.

(1)

- A Epidermis
- B Erector pili
- C Malpighian layer
- D Sebaceous gland

(b) Influenza (flu) is caused by a virus.

Sometimes antibiotics are used as part of the treatment for a person with influenza. Suggest why antibiotics may be used as part of the treatment for influenza.

(2)

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* (c) The overuse of antibiotics is causing concern. The table below shows the number of prescriptions for antibiotics per 10 000 population in the USA, given during treatment for influenza, from 2000 to 2006.

Year	Number of prescriptions per 10 000 population
2000	226
2002	164
2004	172
2006	142

- X (i) Calculate the overall percentage reduction in the number of prescriptions per 10 000 population in the USA from 2000 to 2006.
Show your working.

(2)

Answer%

- (ii) The target set by health authorities in the USA for the number of prescriptions per 10 000 population by 2012 is 128, an overall reduction of 43.4% since 2000.
Suggest whether this target will be achieved. Give an explanation for your answer.

(3)

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- (iii) Suggest why health authorities in the USA are encouraging the reduction in the number of prescriptions of antibiotics.

(2)

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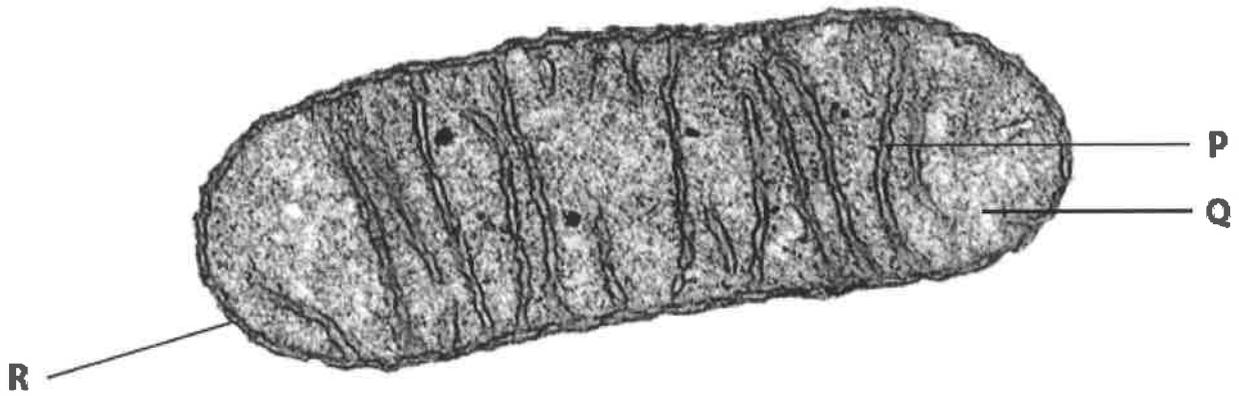
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(Total for question = 12 marks)



CNRI / Science Photo Library
Magnification x 90 000

Name the labelled structures shown in the photograph above.

P

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Q

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R

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(ii) Explain the function of mitochondria in sperm cells.

(3)

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* (c) In some species of mammal, at fertilisation most of the sperm cell enters the egg cell. The fertilised cell then divides by mitosis.

(i) A sperm cell containing 65 mitochondria fertilises an egg cell containing 100 000 mitochondria. Calculate the percentage of the total mitochondria in this fertilised cell that come from the sperm cell. Show your working.

(2)

Answer %
(ii) State how many cells there would be after the fertilised egg has divided, by mitosis, **four** times. (1)

(Total for question = 10 marks)

14

Molecules are transported into and out of cells by several mechanisms.

(a) Read through the following passage that describes some of these mechanisms, then write on the dotted lines the most appropriate word or words to complete the passage.

(4)

Some molecules move across a cell surface membrane by passing down a concentration gradient, through the phospholipid bilayer. The movement of some polar molecules across the membrane involves carrier and channel

..... molecules. When this movement occurs down a

concentration gradient, the process is called and

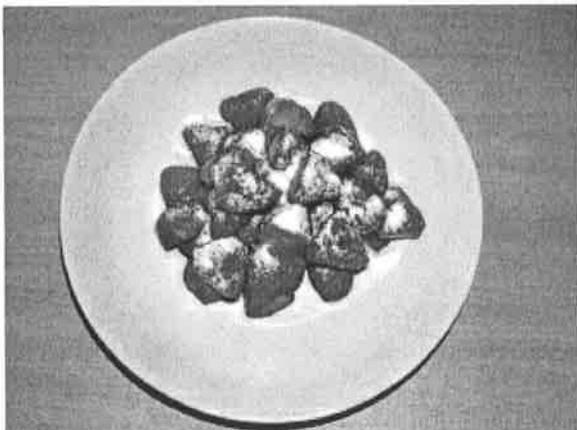
when it occurs against a concentration gradient the process is called

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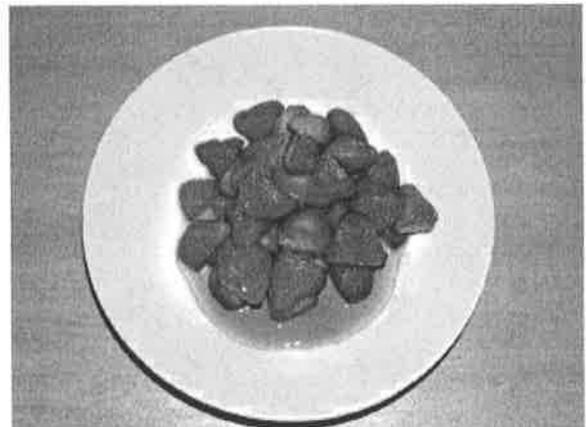
Energy in the form of is used in the movement of

molecules against a concentration gradient.

(b) A student wanted to sweeten some strawberries, so she sprinkled some sugar on top of them, one hour before eating them. The student noticed that the sugar that she had sprinkled on them was no longer visible and that there was some juice at the bottom of the bowl.



Appearance on adding sugar



Appearance one hour after adding sugar

The student thought that the juice was the sugar dissolved in water and that the water had come from the fruit.

In order to test this hypothesis, she weighed some fresh strawberries and sprinkled them with sugar. One hour later she rinsed off the juice and reweighed the strawberries. The mass of the strawberries before adding the sugar was 77 g. The mass after rinsing off the juice was 70 g.

(i) Calculate the percentage decrease in the mass of the strawberries.

Show your working.

(2)

The process of photosynthesis has two main stages. The first of these involves the light-dependent reactions.

(a) The statements below describe important parts of the light-dependent reactions of photosynthesis.

Place a cross in the box next to the term that completes each statement correctly.

(i) When light is absorbed by chlorophyll, it excites

(1)

- A electrons
- B neutrons
- C photons
- D protons

(ii) Oxygen is produced when water molecules are split in the process of

(1)

- A analysis
- B autolysis
- C hydrolysis
- D photolysis

(iii) The products of the light-dependent reactions that are used in the light-independent reactions are reduced NADP and

(1)

- A ATP
- B GALP
- C DNA
- D RuBP

(b) Describe the structures in a chloroplast that are involved in the light-dependent reactions of photosynthesis.

(3)

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* (c) In an investigation, wheat plants were grown using artificial lighting. Three different types of lighting were used. When the wheat plants were mature, the total biomass of the plants and the mass of the grain (seeds) they produced were measured for each type of lighting.

The table below shows the results of this investigation.

Type of lighting	Total biomass / kg	Mass of grain / kg	Grain yield as a percentage of total biomass (%)
Low pressure sodium lamps	171	61.7	36.1
High pressure sodium lamps	159	58.8	37.0
Metal halide lamps	162	62.4	

* (i) Calculate the grain yield, as a percentage of total biomass, for the wheat grown under metal halide lamps. Show your working. (2)

Answer%

(ii) With reference to the data in the table, suggest the conclusions the investigators may have made about the effect of using different types of lighting on grain yield. (3)

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(iii) Suggest **two** advantages of growing crops of wheat in glasshouses with artificial lighting rather than growing them in open fields. (2)

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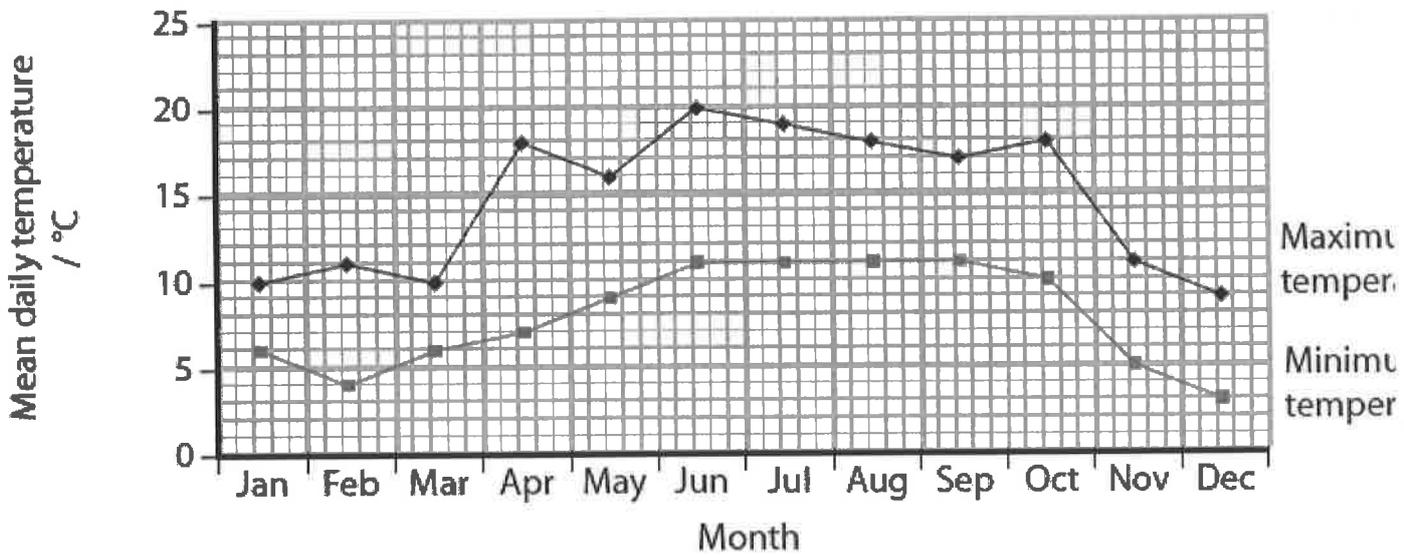
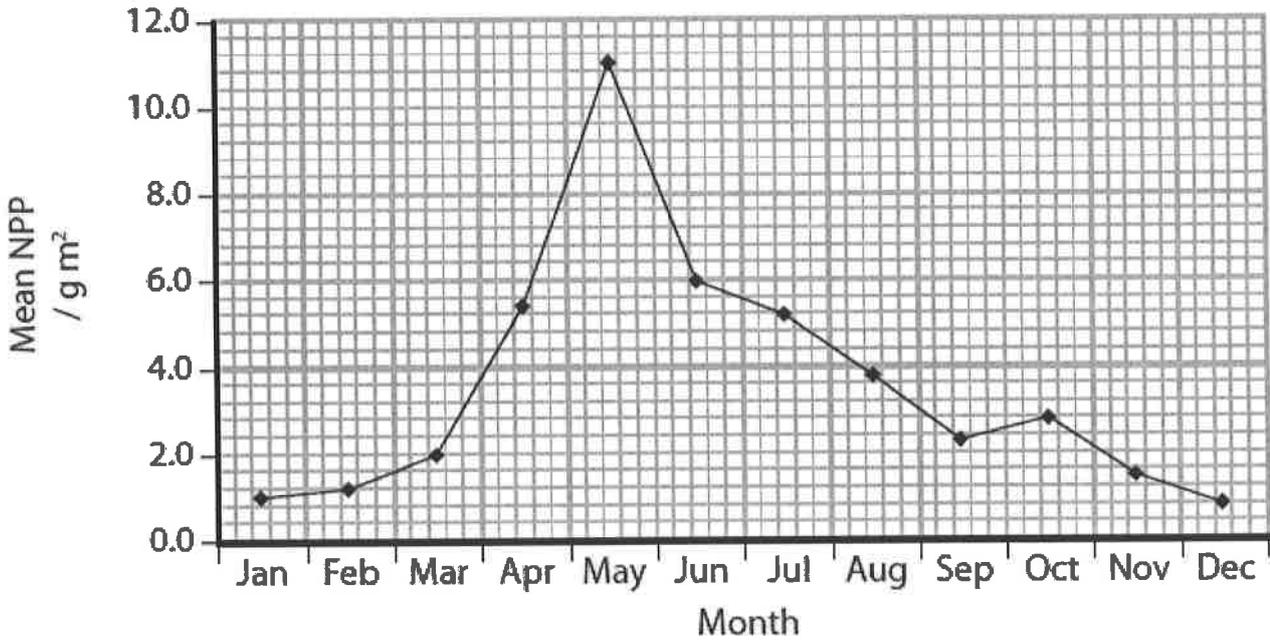
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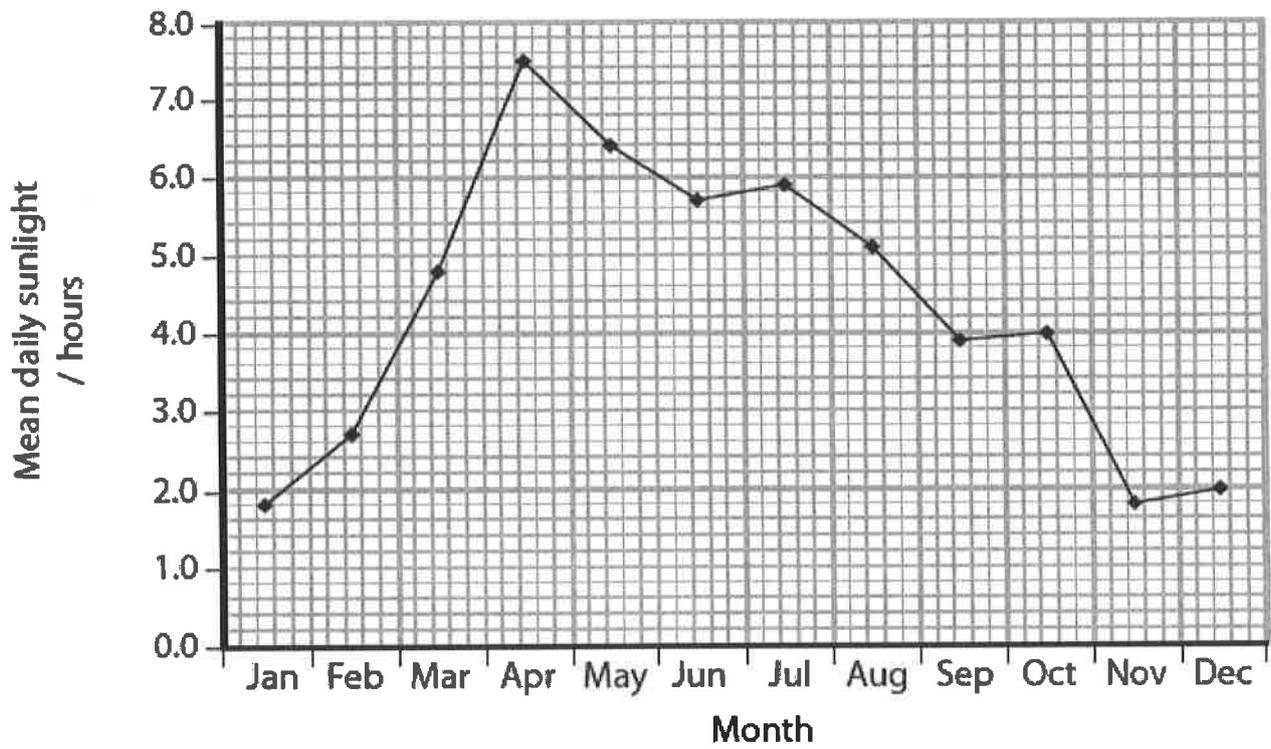
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(Total for question = 13 marks)

The graphs below show data collected at a weather station in North Wales during 2007. The monthly means of net primary productivity (NPP), daily maximum and minimum temperatures and sunlight hours are shown for grassland at this weather station.





(a) (i) Explain what is meant by the term **net primary productivity**.

(2)

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~~*~~ (ii) Calculate the overall percentage increase in the mean NPP from January to May.

(3)

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(b) Suggest why an increase in temperature may cause an increase in NPP.

(2)

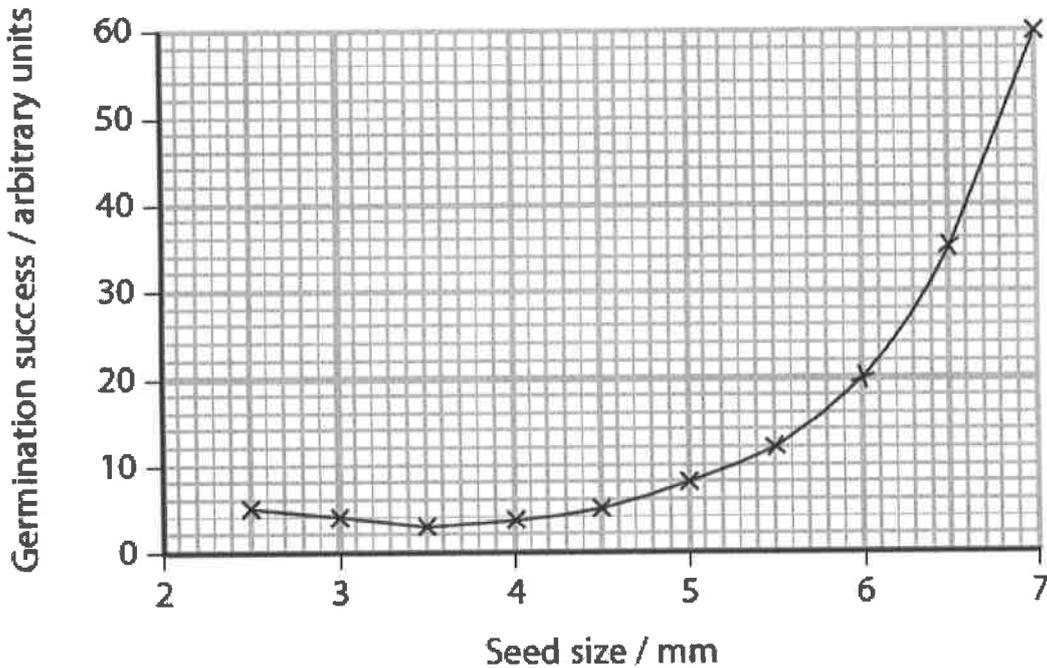
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Seedbanks help in the long-term conservation of rare plant species by conserving the seeds of these species.

(a) Seedbanks carry out a variety of tests to select the best individual seeds to conserve. The germination success of the seeds is one of the tests that is carried out.

The graph below shows the effect of seed size on germination success for one species of plant.



(i) Using the information in the graph, suggest which seed size would be considered the best for the seedbank to conserve, giving a reason for your answer.

(1)

.....

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.....

(ii) Using the information in the graph, calculate the percentage change in germination success when seed size increases from 3 mm to 6 mm. Show your working.

(3)

Answer %

(iii) Seed size may be determined by the genotype of the seeds. Suggest advantages of selecting seeds of different sizes for long-term storage.

(3)

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- * (ii) The gorilla population in one area, Virunga, has been regularly monitored (**Table 24.1**). The data have been collected by indirect methods such as collecting dung samples at nest sites. However, DNA analysis of another gorilla population suggests that estimates made by these indirect methods may be up to 6% inaccurate.

Year	Population in Virunga
1981	254
1989	320
2003	380
2010	480

Table 24.1

Calculate the mean annual percentage rate of growth of the gorilla population in Virunga between 1981 and 2010.

Show your working.

Answer.....% [2]

- (iii) In 1993 the Rio Convention on Biodiversity came into force. In 2010, one conservationist commented that the Rio Convention had had a real effect on the gorilla population.

Use the information above to evaluate the effect that the Rio Convention on Biodiversity has had on the gorillas in Virunga.

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..... [3]

19 . 2

Calculate the percentage drop in FEV for group C compared with the healthy people.

[1 mark]

Answer = _____

19 . 3

Asthma affects bronchioles and reduces flow of air in and out of the lungs. Fibrosis does not affect bronchioles; it reduces the volume of the lungs.

Which group, B or C, was the one containing people with fibrosis of their lungs? Use the information provided and evidence from **Figure 2** to explain your answer.

[3 marks]

[Extra space]

4

Breathing out as hard as you can is called forced expiration.

20

1

Describe and explain the mechanism that causes forced expiration.

[4 marks]

Two groups of people volunteered to take part in an experiment.

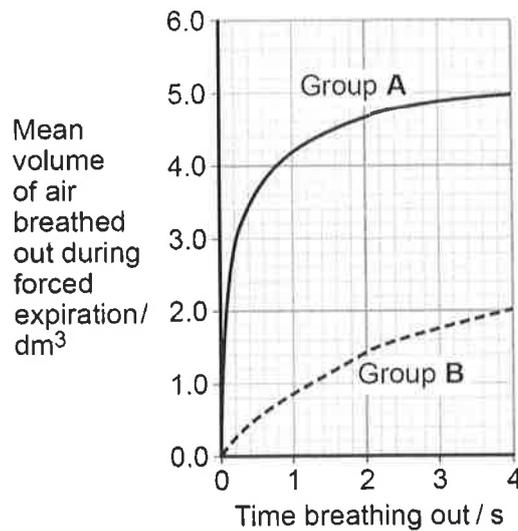
- People in group A were healthy.
- People in group B were recovering from an asthma attack.

Each person breathed in as deeply as they could. They then breathed out by forced expiration.

A scientist measured the volume of air breathed out during forced expiration by each person.

Figure 4 shows the results.

Figure 4



*

204

2 Forced expiration volume (FEV) is the volume of air a person can breathe out in 1 second.

Using data from the first second of forced expiration, calculate the percentage decrease in the FEV for group B compared with group A.

[1 mark]

Answer = _____ %

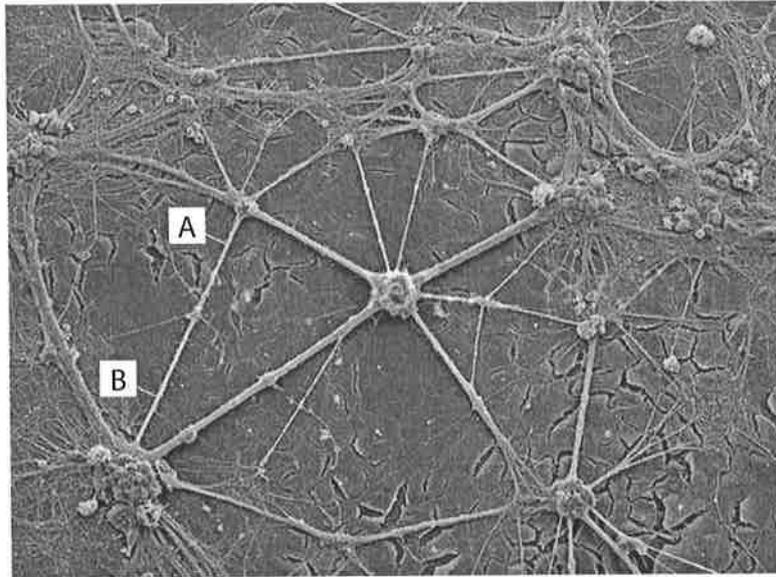
204

3 The people in group B were recovering from an asthma attack. Explain how an asthma attack caused the drop in the mean FEV shown in Figure 4.

[4 marks]

[Extra space]

21 The photomicrograph below shows myelinated neurones.



© C016/7131 David Scharf/Science Photo Library

Magnification $\times 226$

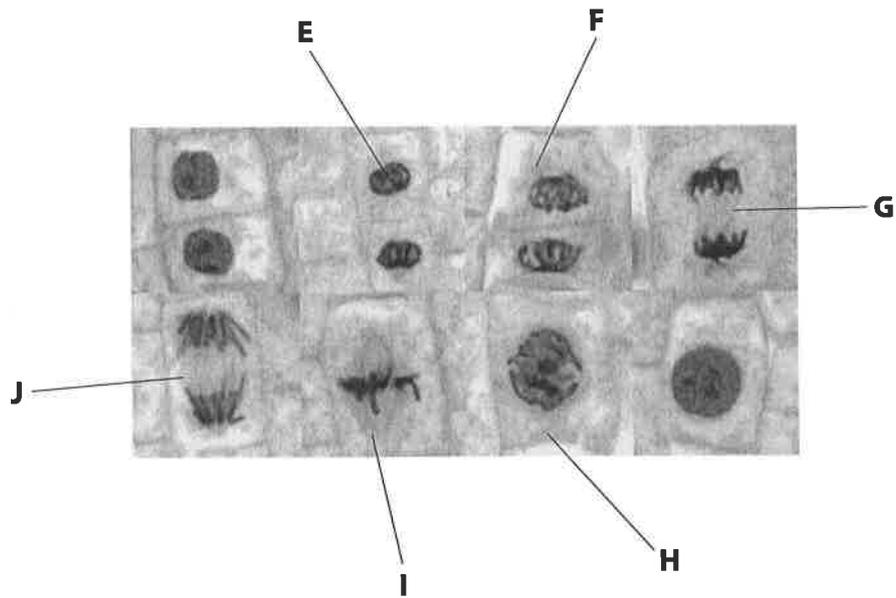
- X (a) The time taken for an impulse to travel between two electrodes placed at the points labelled **A** and **B** was measured as 0.02 milliseconds.

Calculate the speed of the impulse.

(3)

Answerms⁻¹

22 The photograph below shows cells dividing by mitosis.



© Steve Gschmeissner / Science Photo Library

(a) The actual length of cell **J** is $23.5 \mu\text{m}$.

* (i) Calculate the magnification of this photograph.

(3)

Answer

Answer all questions in the spaces provided.

23

1

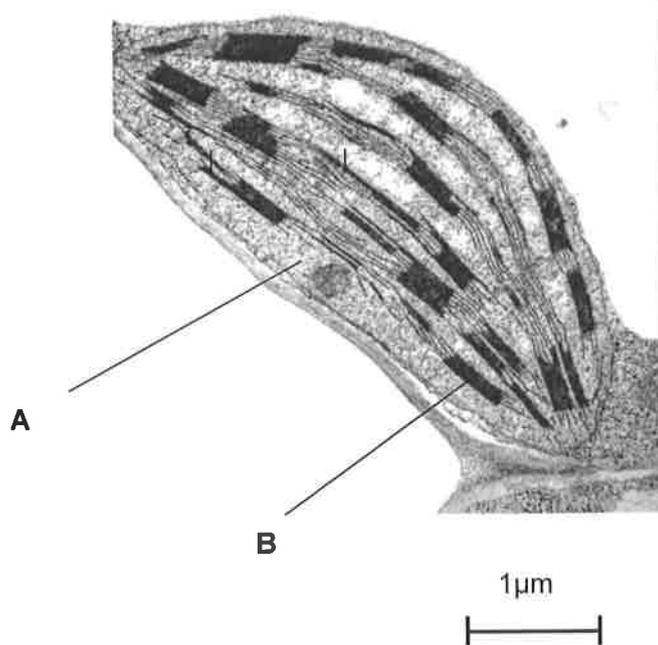
Describe how you could use cell fractionation to isolate chloroplasts from leaf tissue.

[3 marks]

[Extra space]

Figure 1 shows a photograph of a chloroplast taken with an electron microscope.

Figure 1



23 . **2** Name the parts of the chloroplast labelled **A** and **B**.

[2 marks]

Name of **A** _____

Name of **B** _____

23 . **3** Calculate the length of the chloroplast shown in **Figure 1**.

[1 mark]

*

Answer = _____

23 . **4** Name **two** structures in a eukaryotic cell that **cannot** be identified using an optical microscope.

[1 mark]

1 _____

2 _____

Turn over for the next question

209.

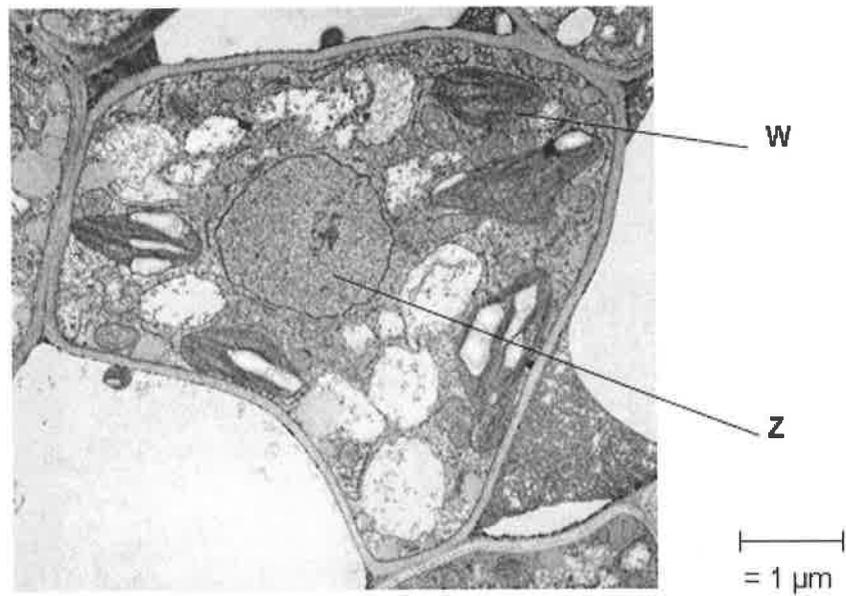
1 Describe how you could make a temporary mount of a piece of plant tissue to observe the position of starch grains in the cells when using an optical (light) microscope.

[4 marks]

[Extra space] _____

Figure 1 shows a microscopic image of a plant cell.

Figure 1



24. **2** Give the name and function of the structures labelled **W** and **Z**. **[2 marks]**

Name of **W** _____

Function of **W** _____

Name of **Z** _____

Function of **Z** _____

24. **3** A transmission electron microscope was used to produce the image in **Figure 1**. Explain why. **[2 marks]**

24. **4** Calculate the magnification of the image shown in **Figure 1**. **[1 mark]**

*

Answer = _____

25

This question is about the impact of potentially harmful chemicals and microorganisms.

- (a) (i) Salts that a plant needs, such as nitrates and phosphates, are taken into root hair cells by active transport.

For which macromolecule does a plant need both nitrogen **and** phosphorus?

..... [1]

- (ii) Flooding of fields by seawater can damage crops. Seawater contains dissolved salts, including sodium chloride.

How would flooding affect soil water potential?

..... [1]

- (iii) Sodium chloride in solution dissociates into Na⁺ and Cl⁻.

Explain how the Casparian strip prevents these ions from reaching the xylem of the plant by the apoplast pathway.

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..... [2]

- (b) Plague is caused by the bacterium, *Yersinia pestis*.

- ✗ (i) The bacterium is a rod-shaped cell that is approximately 3 μm long.

Yersinia pestis is viewed using a light microscope with a magnification of 1250. What would be the length of the cell in the image produced by this microscope?

Answer.....mm [2]

- (ii) Photographs taken of the image obtained by the light microscope could be further enlarged using a projector.

Why might the enlarged image be unable to tell us more about the structure of *Yersinia pestis*?

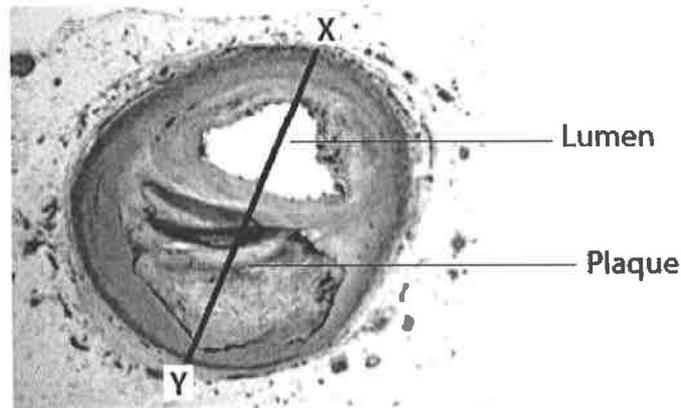
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..... [1]

Questions

26

Cardiovascular disease (CVD) is responsible for many deaths. One cause of CVD is atherosclerosis.

The photograph below shows a section through an artery with a plaque (atheroma) from a patient with CVD.



- ✱ (a) Calculate the increase in the thickness of the artery wall where the plaque is located. Take your measurements along the line labelled **X** and **Y**. Show your working.

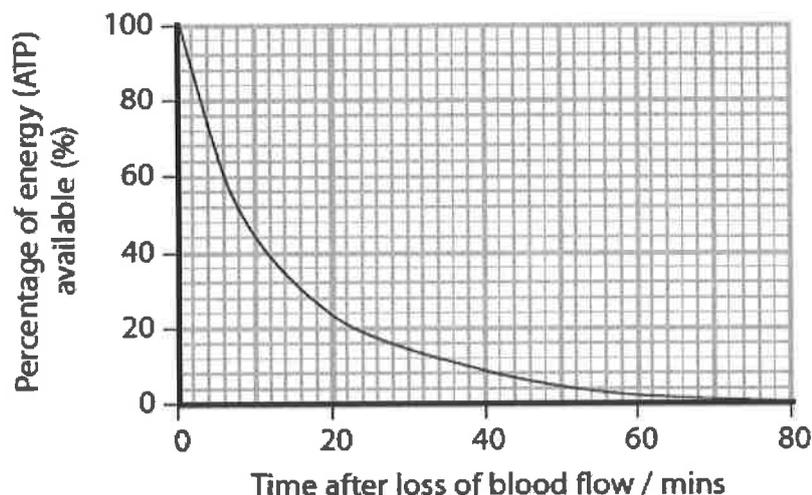
(3)

Answer

(b) The plaque often increases in size and can block the artery. If the artery supplying blood to the heart becomes blocked, blood no longer flows to the heart muscle cells. Shortly after the loss of blood flow, heart muscle cells stop contracting and start to die.

In the heart muscle cells, energy (ATP) is made available from respiration.

The graph below shows how the energy (ATP) available to heart muscle cells changes with time, after the loss of blood flow.



(iii) Describe how molecule Q is produced.

(4)

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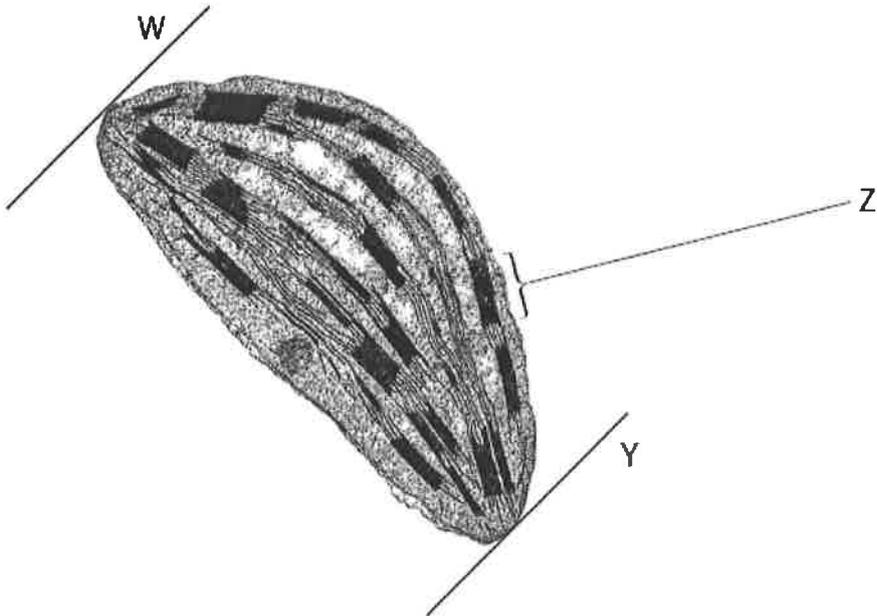
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(b) The electronmicrograph below shows an image of a chloroplast.



(i) Place a cross ☒ in the box next to the name of the part labelled Z.

(1)

- A carbon dioxide

- B** oxidised NADP
- C** reduced NADP
- D** RUBISCO

* (ii) The equation below can be used to calculate the magnification of this chloroplast.

$$\text{image length} = \text{actual length} \times \text{magnification}$$

The actual length of this chloroplast is 0.007 mm.

Measure the image length between lines **W** and **Y**. Use this equation to calculate the magnification of the image.

(3)

magnification =

(iii) Describe the structure of chloroplasts in relation to their roles in photosynthesis.

(3)

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(Total for question = 13 marks)

Questions

28

The table shows information about midday temperatures.

Temperature (t °C)	Number of days
$10 \leq t < 15$	6
$15 \leq t < 20$	4
$20 \leq t < 25$	24
$25 \leq t < 30$	44
$30 \leq t < 35$	10
$35 \leq t < 40$	4

(a) Write down the modal class interval.

.....

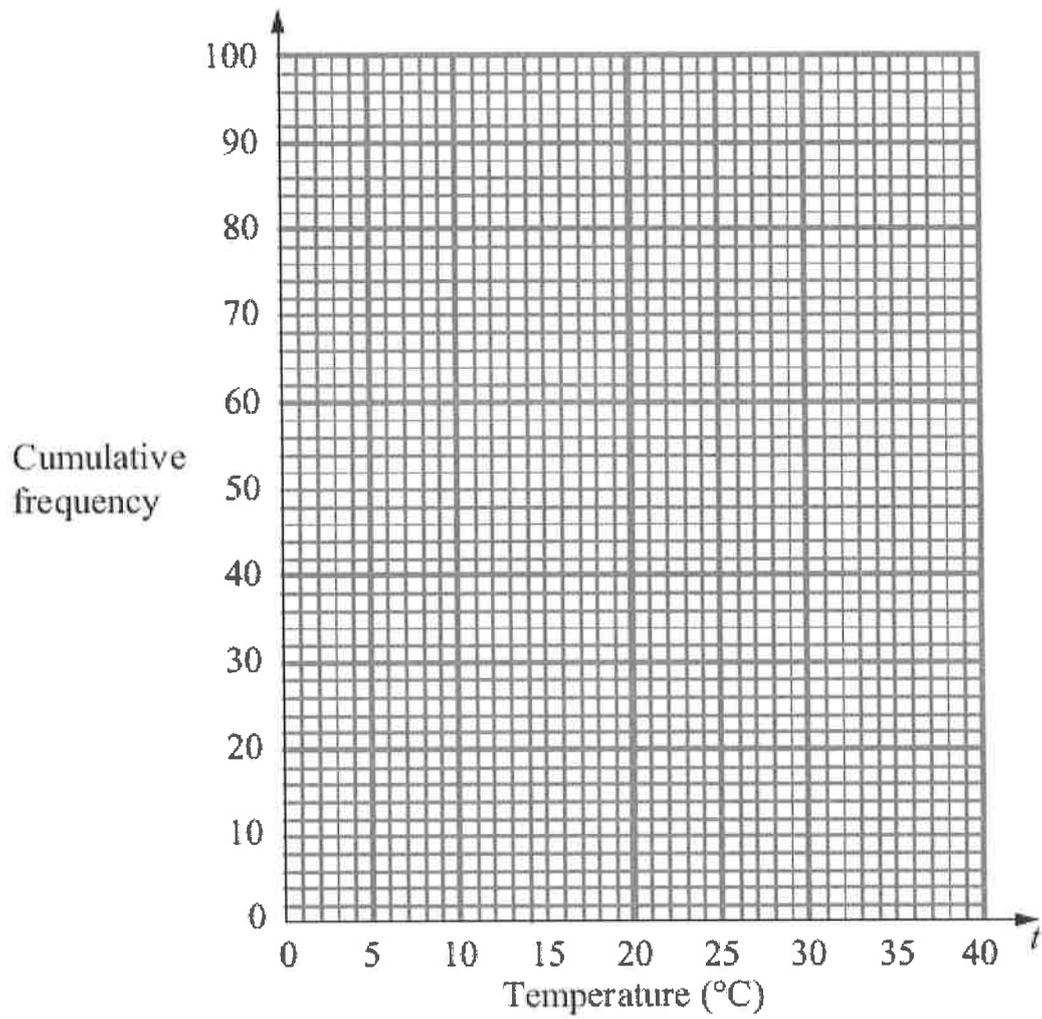
(1)

(b) Work out an estimate for the mean midday temperature.
Give your answer correct to 3 significant figures.

..... °C

(4)

(c) On the grid opposite, draw a cumulative frequency graph for the information from the table about the midday temperatures.



(3)

(d) Find estimates for the median **and** the interquartile range of these midday temperatures.

Median °C

Interquartile range °C

(3)

(Total for Question is 11 marks)

The table shows some information about the weights, in grams, of 60 eggs.

Weight (w grams)	Frequency		
$0 < w \leq 30$	0		
$30 < w \leq 50$	14		
$50 < w \leq 60$	16		
$60 < w \leq 70$	21		
$70 < w \leq 100$	9		

(a) Calculate an estimate for the mean weight of an egg.

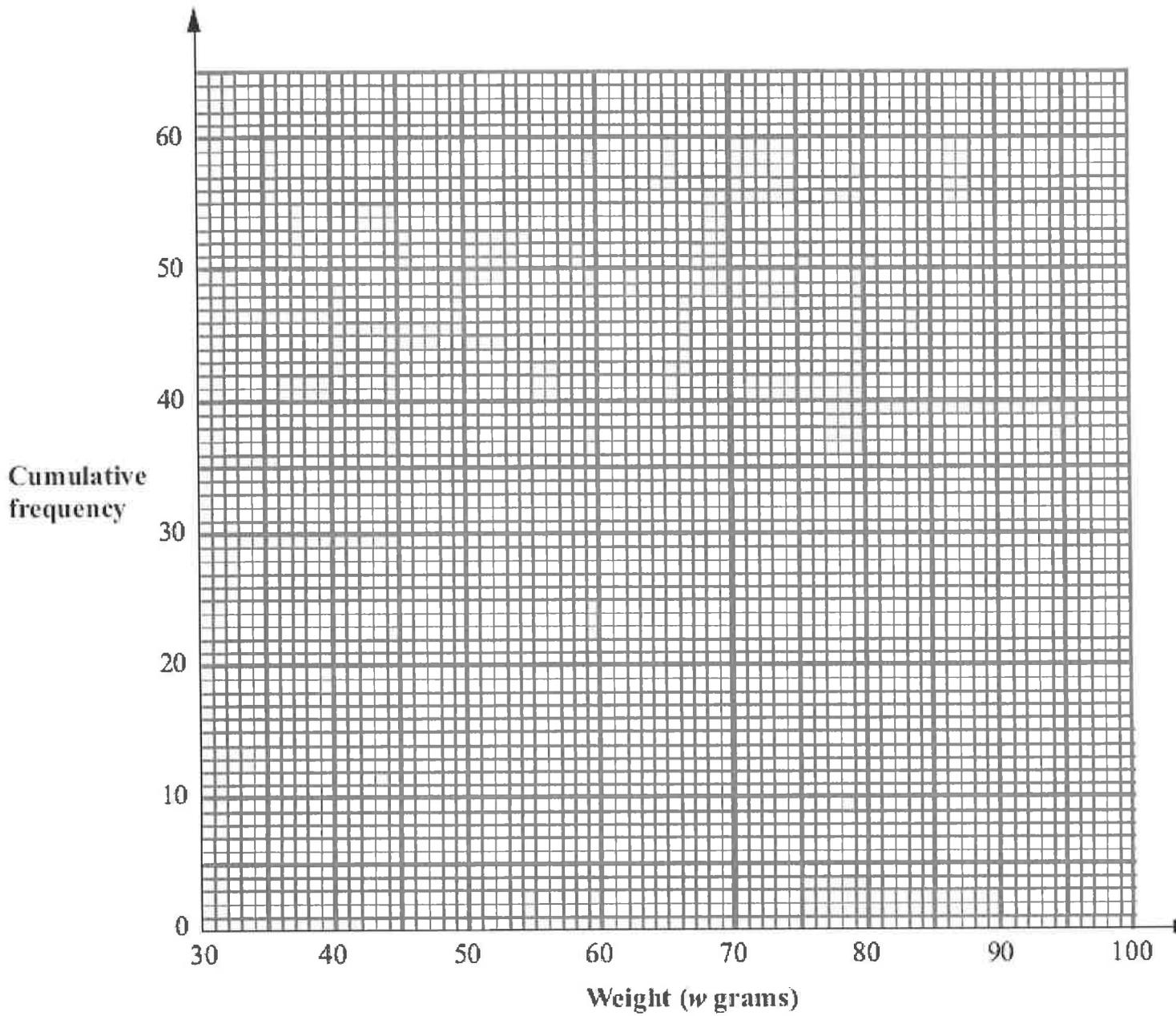
..... g

(4)

(b) Complete the cumulative frequency table.

Weight (w grams)	Cumulative frequency
$0 < w \leq 30$	0
$0 < w \leq 50$	
$0 < w \leq 60$	
$0 < w \leq 70$	
$0 < w \leq 100$	

(1)



(c) On the grid, draw a cumulative frequency graph for your table.

(2)

(d) Use your graph to find an estimate for the number of eggs with a weight greater than 63 grams.

(2)

(Total for Question is 9 marks)

The table shows some information about the times, in minutes, 60 people took to get to work.

Time (x minutes)	Frequency		
$0 < x \leq 10$	5		
$10 < x \leq 30$	11		
$30 < x \leq 50$	23		
$50 < x \leq 80$	13		
$80 < x \leq 100$	8		

(a) Calculate an estimate for the mean.

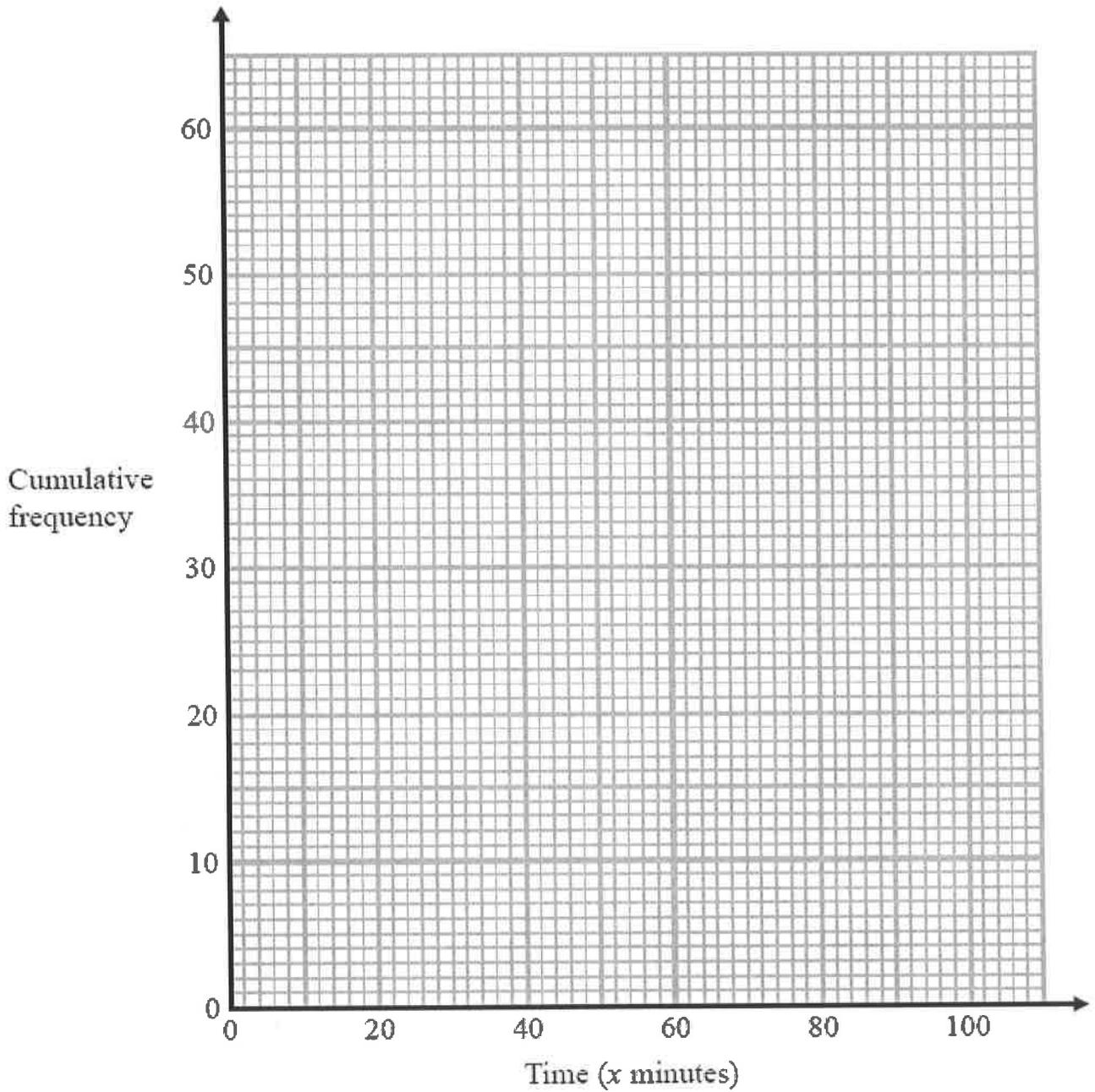
.....minutes
(4)

(b) Complete the cumulative frequency table.

Time (x minutes)	Cumulative frequency
$0 < x \leq 10$	
$0 < x \leq 30$	
$0 < x \leq 50$	
$0 < x \leq 80$	
$0 < x \leq 100$	

(1)

(c) On the grid draw a cumulative frequency graph for your table.



(2)

(d) Find an estimate for the number of people who took **more** than 1 hour to travel to work.

.....
(2)

(Total for Question is 9 marks)

31

23 girls have a mean height of 153 cm.
17 boys have a mean height of 165 cm.

Work out the mean height of all 40 children.

..... cm

(Total for Question is 3 marks)

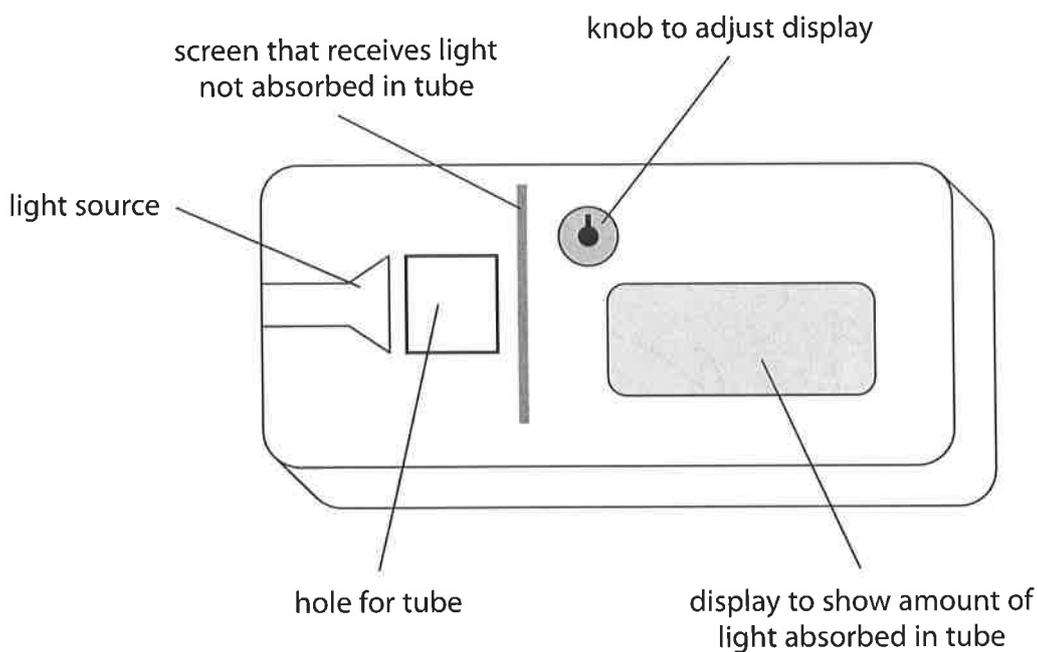
32

When banana flesh is cut or mashed up, a chemical compound called catechol is released which reacts with oxygen to form brown melanin. This reaction is catalysed by the enzyme polyphenol oxidase.



A student investigated the rate of this reaction by using a colorimeter to measure the rate of appearance of the brown colour.

The diagram below shows a colorimeter.



- (a) The student recorded absorbance in the colorimeter every 10 seconds for 60 seconds. He repeated the process and calculated the mean for each 10-second period. The results are shown in the table.

Time in colorimeter / s	Mean absorbance / absorbance units
0	0.2
10	0.8
20	1.3
30	1.6
40	1.8
50	1.9
60	1.9

* (i) Calculate the mean rate for the first 20 seconds of this reaction.

(3)

Answer.....

(ii) Explain why the mean rate changes after the first 20 seconds of this reaction.

(3)

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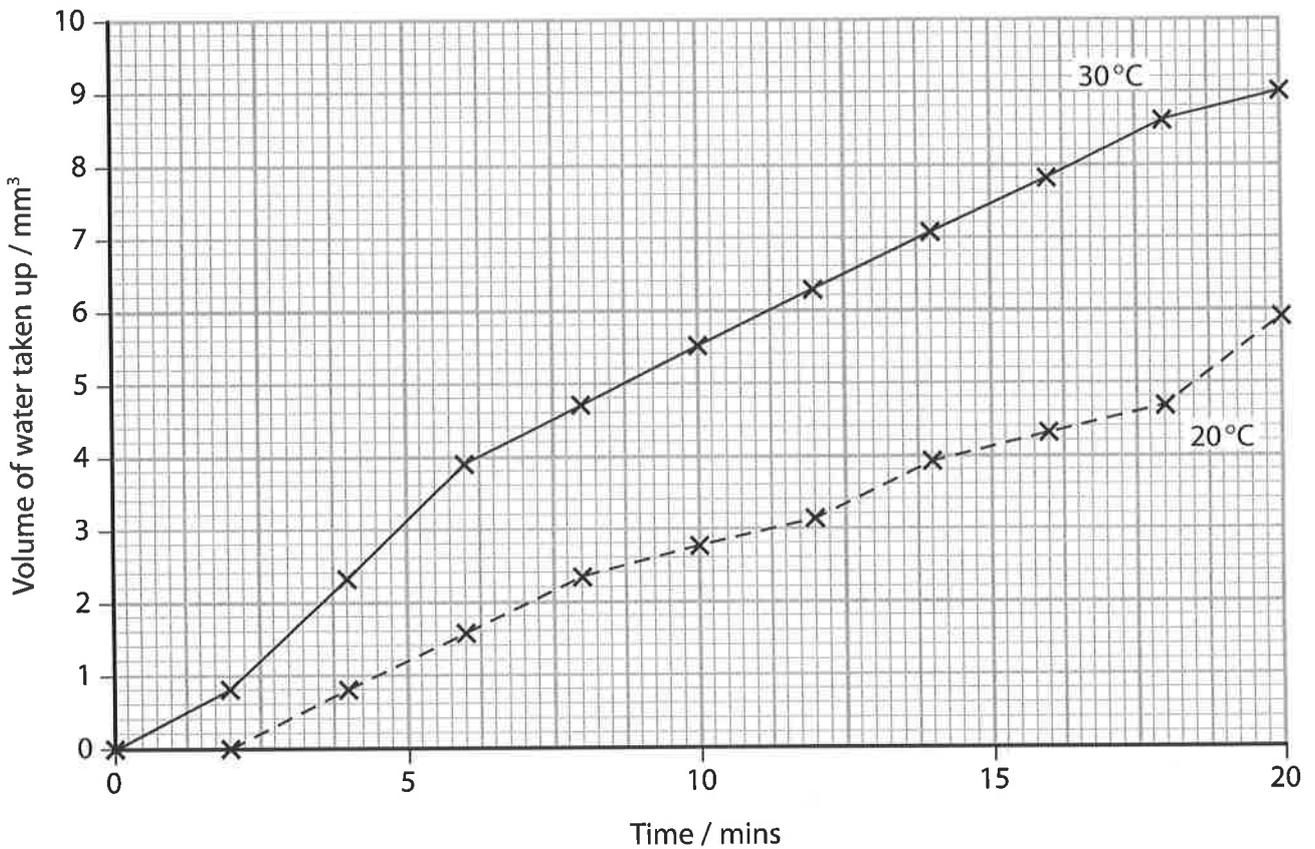
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33

A student used a potometer to investigate the effect of temperature on the uptake of water by a plant shoot. The potometer was set up in a room at 30 °C and the volume of water taken up by the shoot was recorded for a period of 20 minutes.

The potometer was then moved to a room at 20 °C. After a period of acclimatisation, the volume of water taken up by the shoot was recorded for a further 20 minutes.

The results of the investigation are shown in the graph.



- X (a) Calculate the mean transpiration rate for this shoot at 30 °C between 6 and 18 minutes.

(3)

Answer.....

34

A student investigating the factors affecting the heart rate of humans carried out a trial to find out the most reliable method of counting the number of heartbeats in one minute.

She counted the number of pulses in one minute of a single subject in identical conditions using two different methods.

Method A – she counted the number of pulses for 15 seconds and multiplied the result by 4.

Method B – she counted the number of pulses continuously for one minute.

The table below shows the results of six trials for each method.

Method	Pulse rate / beats min ⁻¹						Mean pulse rate / beats min ⁻¹	Standard deviation
A	64	60	68	76	64	72	67.3	5.9
B	63	59	69	58	71	74	65.7	

- * (a) The student calculated the standard deviation for method A using the following formula:

$$\sigma = \sqrt{\frac{\sum[x - \bar{x}]^2}{n - 1}}$$

- * Calculate the standard deviation for method B.

(3)

Answer

35

(b) A study was carried out to investigate the benefit of treating patients who are over 80 and have high blood pressure.

Patients were randomly put into one of two groups, A and B. Each group contained 2000 patients.

Patients in group A were given two tablets each containing a different drug.

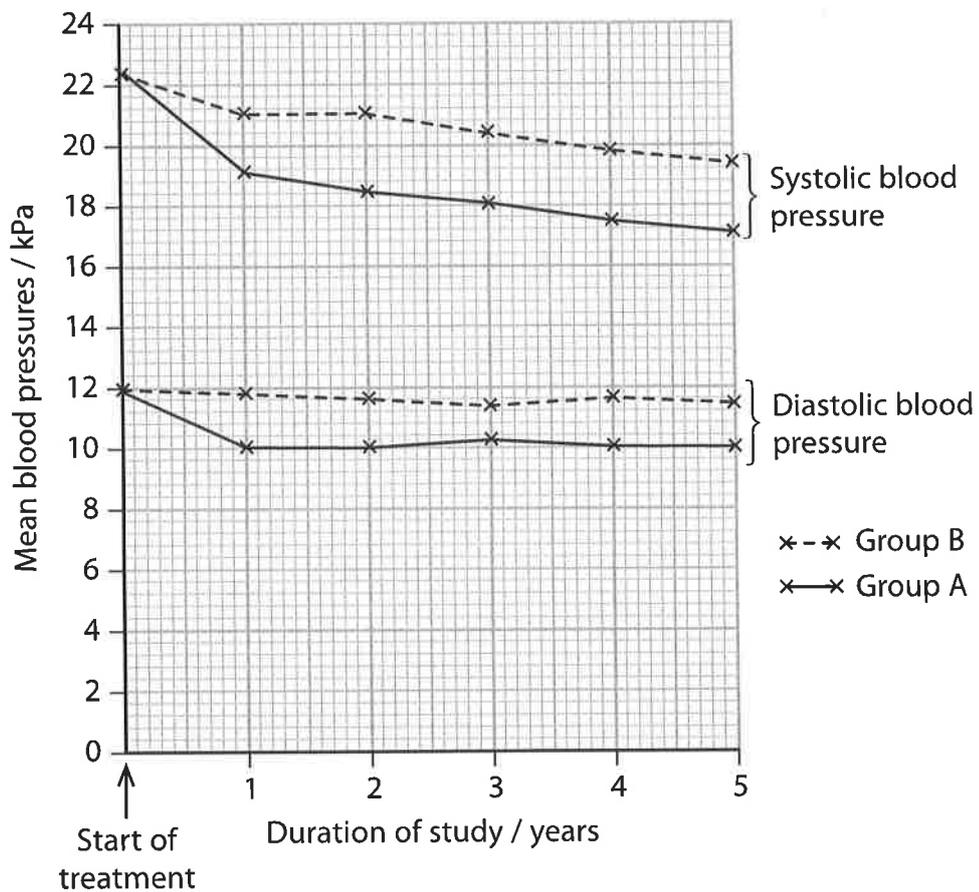
Patients in group B were given two tablets neither of which contained a drug.

The systolic and the diastolic pressure of each patient was measured. The systolic pressure is the maximum pressure when the heart contracts and the diastolic pressure is the minimum pressure when the heart relaxes.

The blood pressure of all patients was recorded over a period of five years.

The mean pressures were then calculated.

The graph below shows the results of this study.



(i) Explain why the patients in group B were given two tablets that had no drugs in them.

(2)

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* (ii) Using the information in the graph, describe the results of this study.

(3)

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(iii) Suggest why both the systolic and diastolic blood pressures were recorded in this study.

(1)

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.....

(iv) Suggest what else could have been recorded in this study to provide more evidence of other benefits of treating these patients with the drugs.

(1)

.....

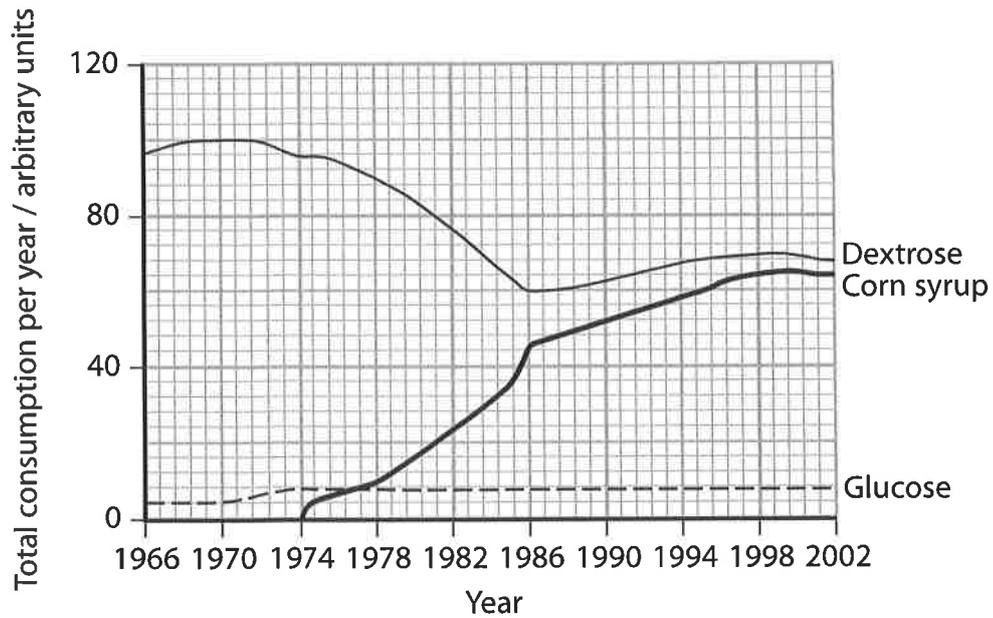
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(Total for Question 7 = 10 marks)



36

- (d) The graph below shows the consumption of three types of sweetener in the USA, from 1966 to 2002.



From 1976, the number of obese people in the USA started to increase rapidly. It was suggested that there was a correlation between the consumption of corn syrup and obesity.

- * (i) Explain the meaning of the term **correlation**.

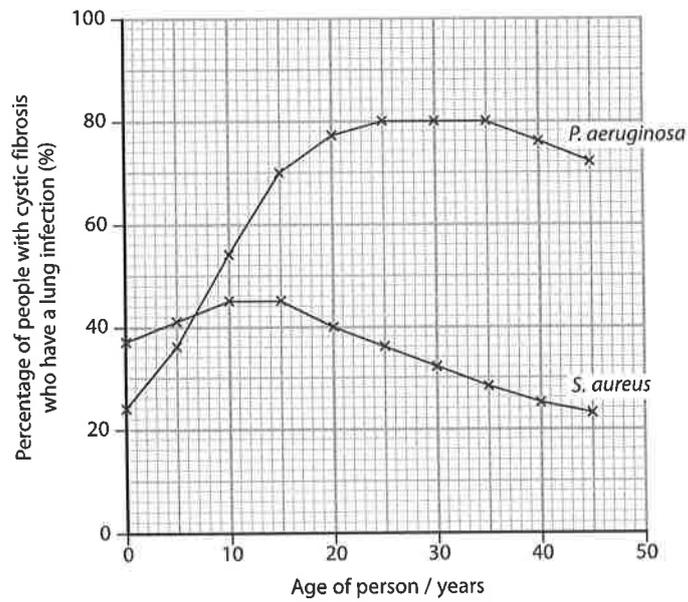
(1)



37

(b) Lung infections can be caused by bacteria such as *P. aeruginosa* and *S. aureus*. People with cystic fibrosis may develop these lung infections.

The graph below shows the relationship between the percentage of people with cystic fibrosis who have a lung infection and the age of the person.



(i) Suggest why people with cystic fibrosis are more likely to suffer from these lung infections than people without cystic fibrosis.

(2)



* (ii) Using the information in the graph, describe the relationship between the age of a person and the incidence of a lung infection due to *P. aeruginosa*. (3)

(iii) Using the information in the graph, give **two** differences between the percentages of people with infections due to *P. aeruginosa* and infections due to *S. aureus*. (2)

1

2

(Total for Question 5 = 12 marks)



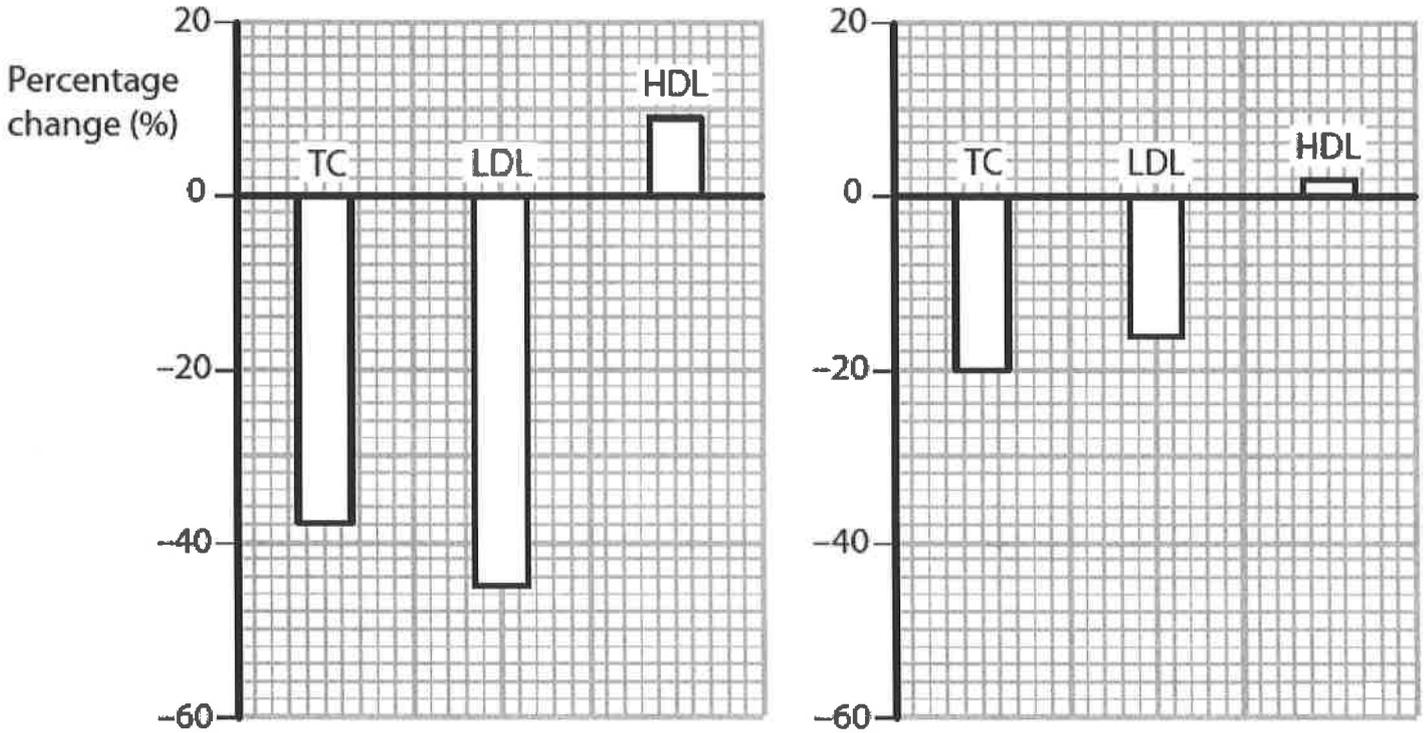
Questions

38

High blood cholesterol levels are associated with an increased risk of developing cardiovascular disease (CVD). There are cholesterol-reducing drugs available to lower this risk.

(a) Two groups of patients were treated with a different type of cholesterol-reducing drug, Drug A or Drug B.

The graphs below show the percentage changes of total cholesterol (TC), lowdensity lipoproteins (LDL) and high-density lipoproteins (HDL) in the blood of these patients, after treatment.



Patients treated with Drug A

Patients treated with Drug B

* (i) Compare the effects of Drug A and Drug B on the percentage changes in total cholesterol (TC), LDL and HDL in the blood of these two groups of patients.

(3)

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(ii) The enzyme HMG-CoA reductase catalyses the synthesis of cholesterol. When this enzyme is active, there are fewer LDL receptors on liver cells. These receptors are needed to remove LDL from the blood.

Statins are a group of cholesterol-reducing drugs that act by inhibiting this enzyme. Suggest which of the two drugs, Drug A or Drug B, is more likely to be a statin. Give reasons for your answer.

(3)

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(b) State **two** risks of treatments using statins.

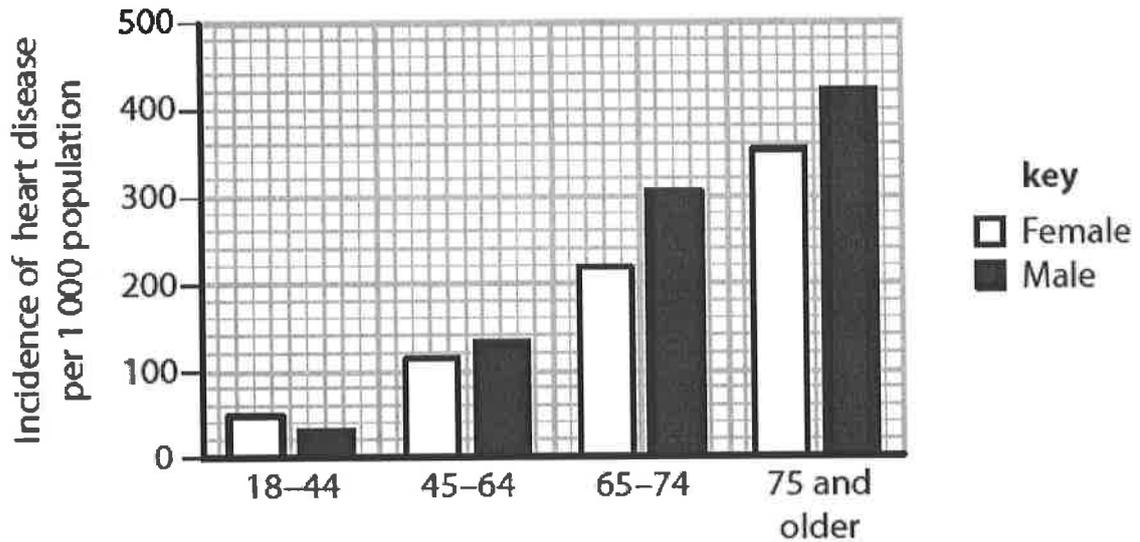
(2)

1

2

(c) Age and gender are two other factors that may influence the development of heart disease in an individual.

The graph below shows the results of a survey in America, on the incidence of heart disease in adults aged 18 and older.



✘ (i) Using the information in the graph, describe how the incidence of heart disease is affected by age and gender.

(3)

(ii) Calculate the increased risk that a man who is 75 or older has of developing heart disease, compared to a man aged between 18 and 44 years old.

(2)

Answer

.....
(Total for question = 13 marks)

Obesity is a significant problem in western countries and an increasing problem in other parts of the world. An obese person has a greater risk of developing heart disease.

Body Mass Index (BMI) is one measure used to help decide if a person's weight is reasonable for their height. The BMI can be calculated by dividing mass in kilograms by height in metres squared. A table is then used to judge if the BMI is reasonable or not. A copy of this table is shown below.

BMI range	Less than 18.5	18.5 to 24.9	25.0 to 29.9	30.0 to 39.9	40.0 or above
Description	Underweight	Healthy weight	Overweight	Obese	Morbidly obese

(a) A man was concerned that he was overweight and could be at risk from coronary heart disease. He was 1.8 m tall and had a mass of 83.0 kg.

(i) Calculate this man's body mass index (BMI) using the formula below.

$$\text{BMI} = \frac{\text{mass in kilogrammes}}{(\text{height in metres})^2}$$

(2)

Answer

(ii) Using the information in the table, interpret this man's BMI.

(2)

.....

.....

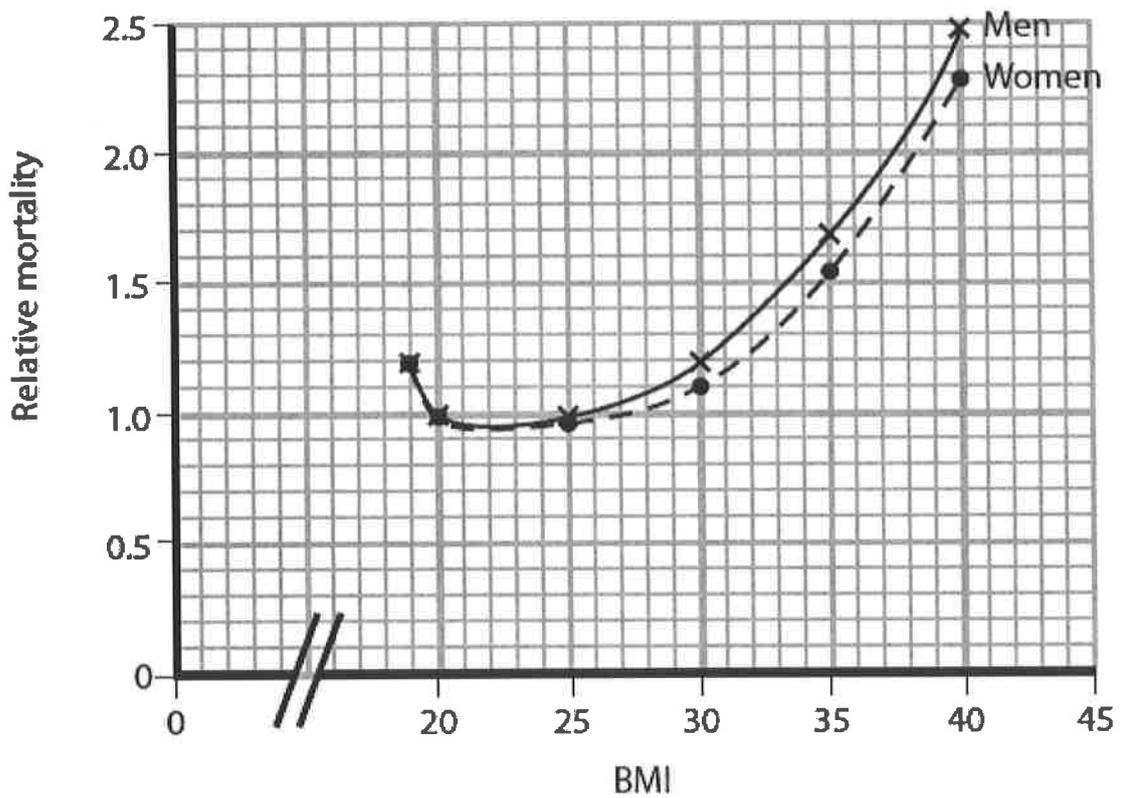
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(b) The graph below shows one analysis of relative mortality compared with BMI, for men and women.



* Compare the effect of BMI on relative mortality for men and women.

(3)

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(c) (i) A relative mortality of 1.2 or less indicates a low risk of dying. Using the information given, discuss whether or not a woman with a BMI of 32.5 should be concerned about her risk of dying.

(2)

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.....

*(ii) Cardiovascular disease (CVD) is responsible for many deaths.

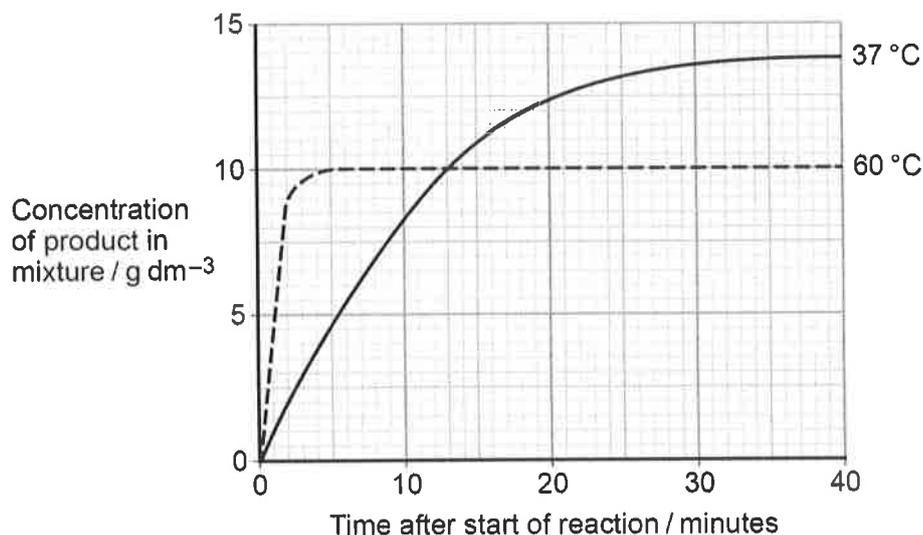
Answer **all** questions in the spaces provided.

40

A technician investigated the effect of temperature on the rate of an enzyme-controlled reaction. At each temperature, he started the reaction using the same concentration of substrate.

Figure 1 shows his results.

Figure 1



40

1 Give **two** other factors the technician would have controlled.

[1 mark]

1 _____

2 _____

40

2 Draw a tangent on each curve to find the initial rates of reaction. Use these values to calculate the ratio of the initial rates of reaction at 60 °C : 37 °C. Show your working.

[2 marks]

Ratio = _____ :1

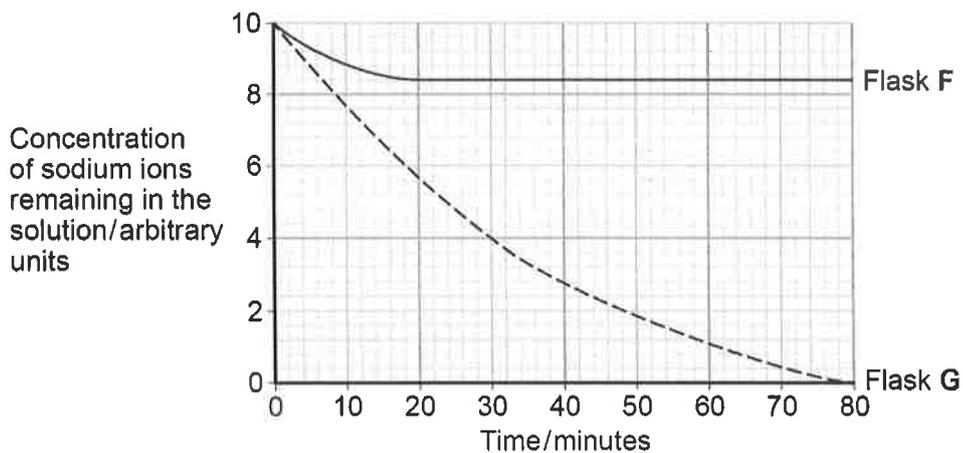
41

A scientist investigated the uptake of sodium ions by animal tissue. To do this, he:

- used two flasks, **F** and **G**
- put equal masses of animal tissue into each flask
- added equal volumes of a solution containing sodium ions to each flask
- added to flask **F** a solution of a substance that prevents the formation of ATP by cells
- measured the concentration of sodium ions **remaining** in the solution in each flask.

Figure 2 shows his results.

Figure 2



41

2

1

Calculate the rate of uptake of sodium ions by the tissue in flask **G** during the first 20 minutes of this investigation.

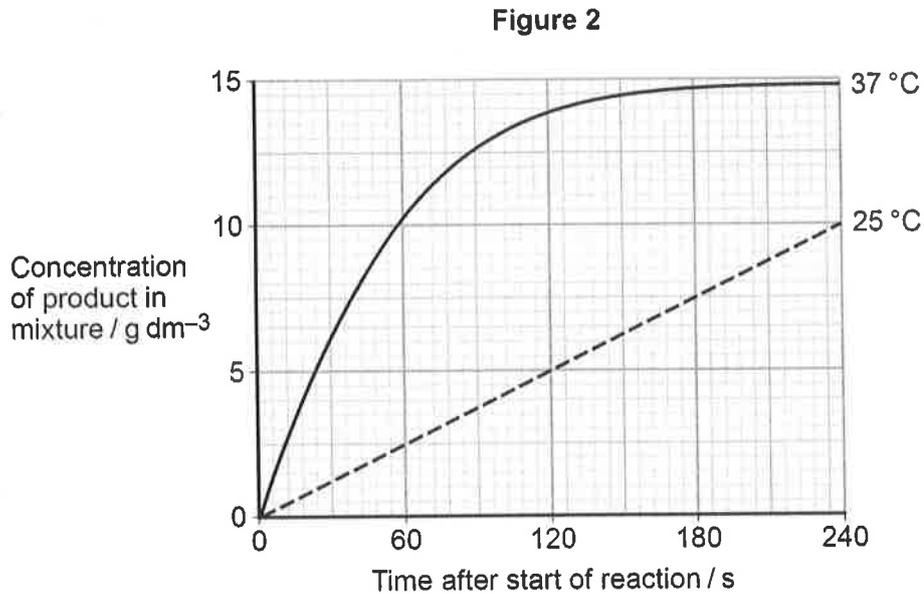
[1 mark]

Answer = _____ arbitrary units per minute

42

A technician investigated the effect of temperature on the rate of an enzyme-controlled reaction. At each temperature, he started the reaction using the same volume of substrate solution and the same volume of enzyme solution.

Figure 2 shows his results.



42

- 1 Give one other factor the technician would have controlled.

[1 mark]

42

- 2 Calculate the rate of reaction at 25 °C.

[2 marks]

*

Answer = _____

43

Amylase is an enzyme that breaks down starch into maltose.

(a) A student investigated the breakdown of starch into maltose. The results are shown in Fig. 2.1.

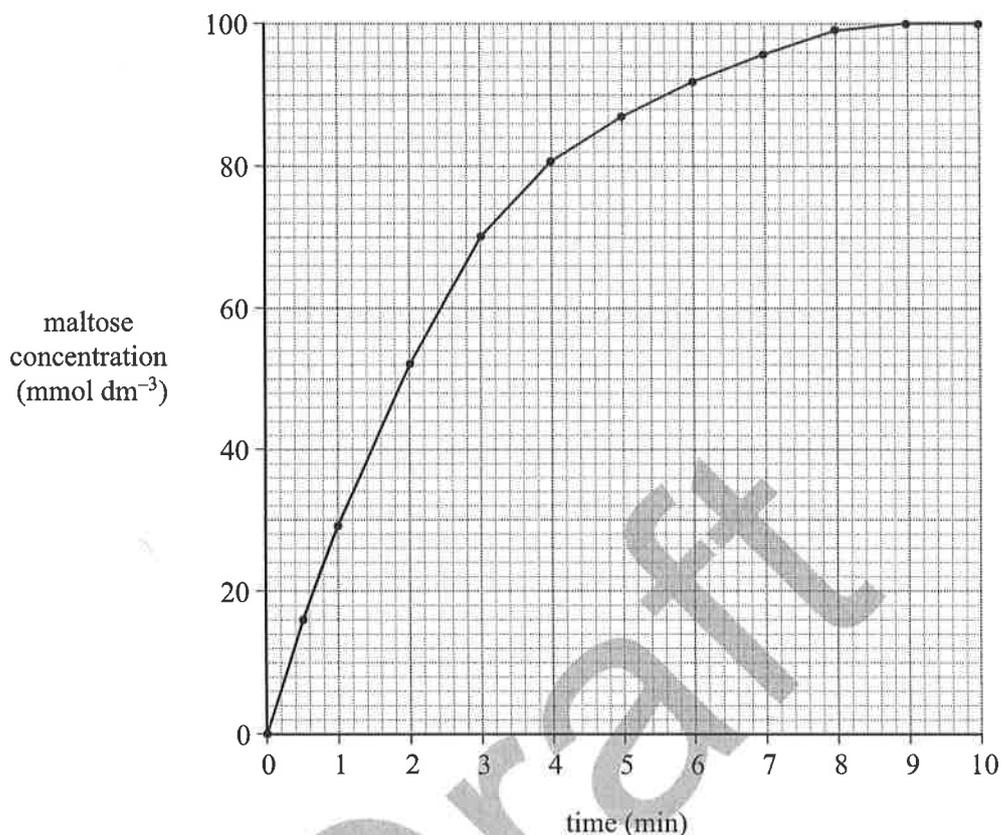


Fig. 2.1

- (i) Calculate the rate of maltose production over the first 30 s.
Show your working and use appropriate units.

Answer..... [2]

- (ii) How would this calculated rate differ from the 'true' initial rate of reaction?
Explain your answer.

.....

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..... [3]

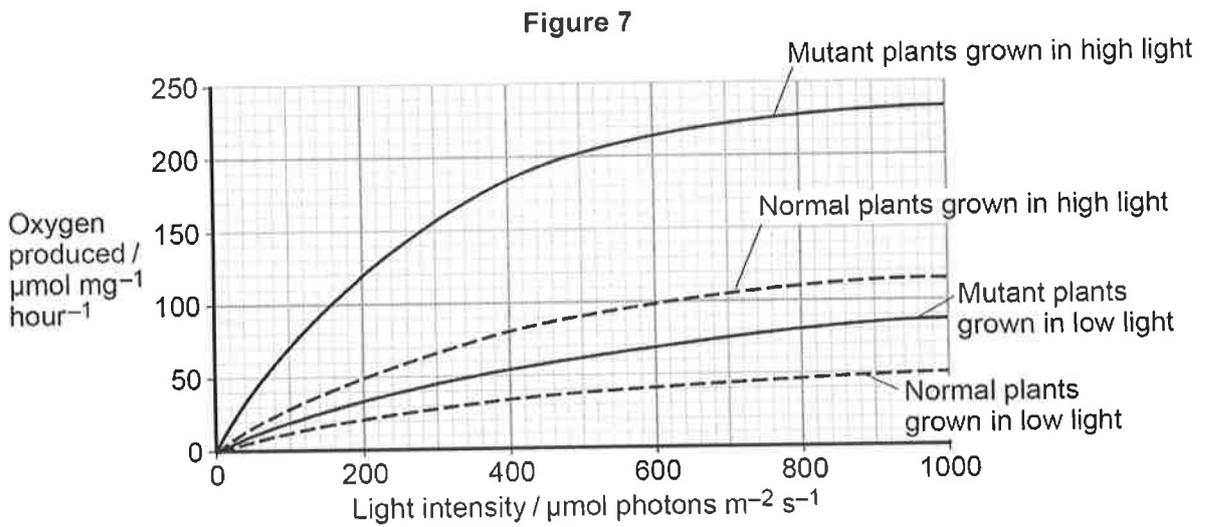
44

Chloroplasts contain chlorophyll a and chlorophyll b. Scientists found tobacco plants with a mutation that caused them to make more chlorophyll b than normal tobacco plants. They investigated the effect of this mutation on the rate of photosynthesis.

The scientists carried out the following investigation.

- They grew normal and mutant tobacco plants. They grew some of each in low light intensity and grew others in high light intensity.
- They isolated samples of chloroplasts from mature plants of both types.
- Finally, they measured oxygen production by the chloroplasts they had isolated from the plants.

Figure 7 shows the scientists' results.



44

1 Explain why the scientists measured the rate of production of oxygen in this investigation.

[2 marks]

In each trial, the scientists collected oxygen for 15 minutes.

44.

2

Calculate the difference in the oxygen produced by the chloroplasts from mutant plants grown in low and high light intensities at a light intensity of $500 \mu\text{mol photons m}^{-2} \text{s}^{-1}$.

*

Show your working.

[2 marks]

Difference _____ $\mu\text{mol O}_2 \text{ mg}^{-1}$

44.

3

The scientists suggested that mutant plants producing more chlorophyll b would grow faster than normal plants in all light intensities.

Explain how these data support this suggestion.

[4 marks]

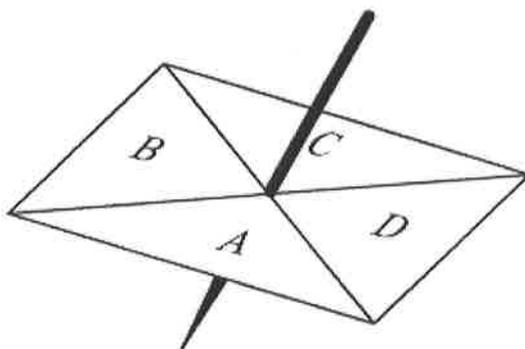
[Extra space]

Questions

45

Sandy has a 4-sided spinner.
The sides of the spinner are labelled A, B, C and D.
The spinner is biased.

The table shows the probability that the spinner will land on A or on B or on C.



Side	A	B	C	D
Probability	0.15	0.32	0.27	

(a) Work out the probability that the spinner will land on D.

.....

(2)

Sandy spins the spinner 300 times.

(b) Work out an estimate for the number of times the spinner will land on A.

.....

(2)

(Total for Question is 4 marks)

46

There are yellow discs, red discs, blue discs and green discs in a bag.
Dinesh is going to take at random a disc from the bag.

The table shows each of the probabilities that Dinesh will take a red disc, or a blue disc, or a green disc.

Colour	yellow	red	blue	green
Probability		0.40	0.25	0.15

(a) Work out the probability that he will take a yellow disc.

.....
(2)

Dinesh takes at random a disc from the bag.
He writes down the colour of the disc.
He puts the disc back into the bag.

He will do this 60 times.

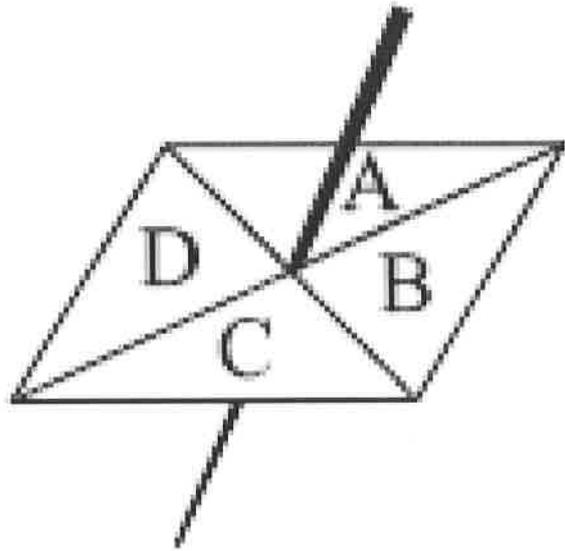
(b) Work out an estimate for the number of times he takes a red disc from the bag.

.....
(2)

(Total for Question is 4 marks)

47

Here is a four-sided spinner.
The sides of the spinner are labelled A, B, C
and D.



The table shows the probability that the spinner will land on A or on B or on D.

Letter	A	B	C	D
Probability	0.12	0.39		0.18

Amber spins the spinner once.

(a) Work out the probability that the spinner will land on C.

.....
(2)

Lucy is going to spin the spinner 50 times.

(b) Work out an estimate for the number of times the spinner will land on A.

.....
(2)

(Total for Question is 4 marks)

Questions

48

$$y = 4x + c$$

$$x = 7.5$$

$$c = 5.4$$

(a) Work out the value of y .

.....

(2)

$$y = 4x + c$$

$$y = 18.8$$

$$c = -2.4$$

(b) Work out the value of x .

.....

(2)

(Total for Question is 4 marks)

49

(a) n is an integer.

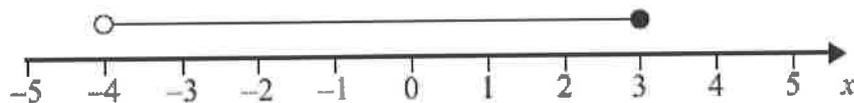
$$-1 \leq n < 4$$

List the possible values of n .

.....

(2)

(b)



Write down the inequality shown in the diagram.

.....

(2)

(c) Solve $3y - 2 > 5$

(2)

(Total for Question is 6 marks)



$$k = 3e + 5$$

(a) Work out the value of k when $e = -2$

.....
(2)

(b) Solve $4y + 3 = 2y + 14$

$y =$
(2)

(c) Solve $3(x - 5) = 21$

$x =$
(2)

$-3 < n < 4$
 n is an integer.

(d) Write down all the possible values of n .

.....
(2)

(Total for Question is 8 marks)

51

Make p the subject of the formula $y = 3p^2 - 4$

.....
(Total for Question is 3 marks)

(d) The mean levels of human lactose intolerance vary in different parts of the world.

Table 18.1 shows the contrasting levels of lactose intolerance in two ethnic groups from different parts of the world.

Population	Frequency of lactose intolerance <i>phenotype</i>
Europeans	0.05
Australian aborigines	0.97

Table. 18.1

The Hardy–Weinberg principle states that:

$$p + q = 1$$

$$p^2 + 2pq + q^2 = 1$$

Where *p* is the frequency of the dominant allele and *q* is the frequency of the recessive allele in the genotypes of a population.

The lactose intolerance allele is recessive to the mutant allele, which prevents lactose intolerance.

Calculate the frequency of the heterozygous genotype in the Australian aborigine population. Show your working.

Draft

Frequency =

[2]

Questions

53

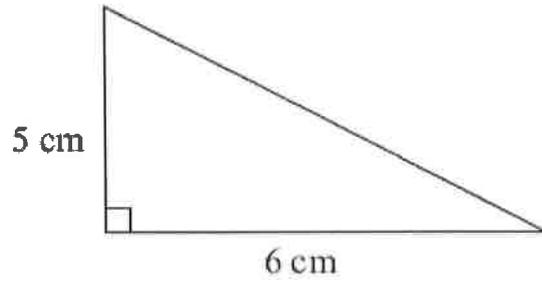


Diagram **NOT** accurately drawn

Work out the area of this triangle.

(Total for Question is 3 marks)

54

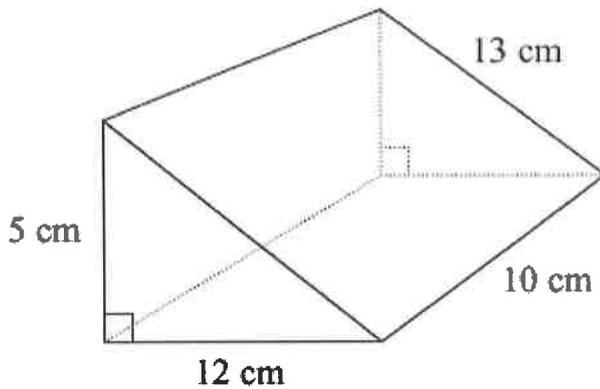


Diagram **NOT** accurately drawn

Work out the total surface area of this triangular prism.

(Total for Question is 4 marks)

13. SS

A piece of card is in the shape of a trapezium.

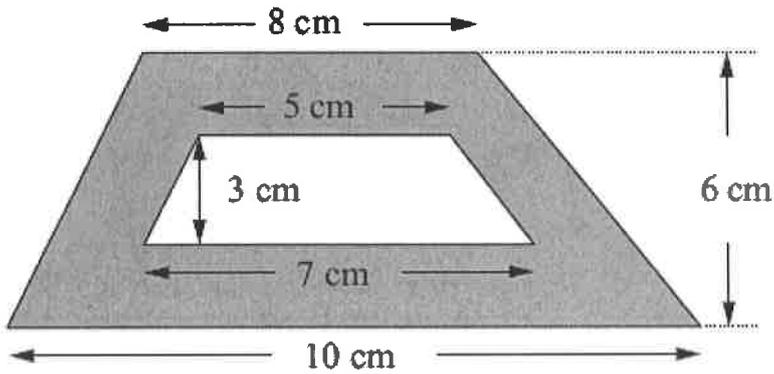


Diagram NOT accurately drawn

A hole is cut in the card.
The hole is in the shape of a trapezium.

Work out the area of the shaded region.

..... cm²

(Total for Question is 3 marks)