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GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE BIOLOGY B

J257
For first teaching in 2016

J257/04 Summer 2019 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

Paper 4 series overview

J257/04, Depth in Biology, is the second of two higher tier examination units for the new revised twenty First Century Science Biology B GCSE. This was the second year of the specification.

The paper assessed content from across the specification and allowed candidates to demonstrate their depth of understanding of specific aspects of the content. As well as short answer response questions there were also structured questions, calculations and questions based on practical skills. This paper also had two extended response questions each with a total of 6 marks.

The assessment of quantitative skills has to include at least 10% GCSE mathematical skills. This was spread throughout the paper, but specifically in Q4, and highlighted an area that candidates were much more aware of this year. (See individual parts for detail). (See section 5d/5e of the specification for details of the skills required).

Many candidates appeared to have been well prepared for the examination, attempting the majority of questions. However, many candidates had problems with Q6 and 7 which are detailed in the next section.

Most candidates used the spaces provided for their responses, very few extending their answers to other parts of the paper. Some candidates, however, did not seem able to limit their answers to the provided space and used the additional examination sheets.

Question 1 (a)

1 Photosynthesis takes place in plants.

(a) Put **one** tick in each row of the table to show the function of each plant structure.

Plant structure	Function		
	Transports sugars made by photosynthesis.	Carries out the reactions of photosynthesis.	Transports water needed for photosynthesis.
Chloroplast			
Phloem			
Xylem			

[1]

Well answered by most candidates. A few candidates were confused by which vessels were involved in the transport of sugars and water.

Question 1 (b)

Eve is investigating the effect of temperature on photosynthesis in pondweed.

This is her method.

1. Put a piece of pondweed in a boiling tube.
2. Cover the pondweed with sodium hydrogen carbonate solution (a source of carbon dioxide).
3. Put the boiling tube in a beaker of water at one of six temperatures.
4. Use a gas syringe to collect the bubbles of gas released from the pondweed.
5. Record the volume of gas collected in five minutes.
6. She repeats the experiment three times at each temperature.

Fig. 1.1 shows the apparatus Eve uses.

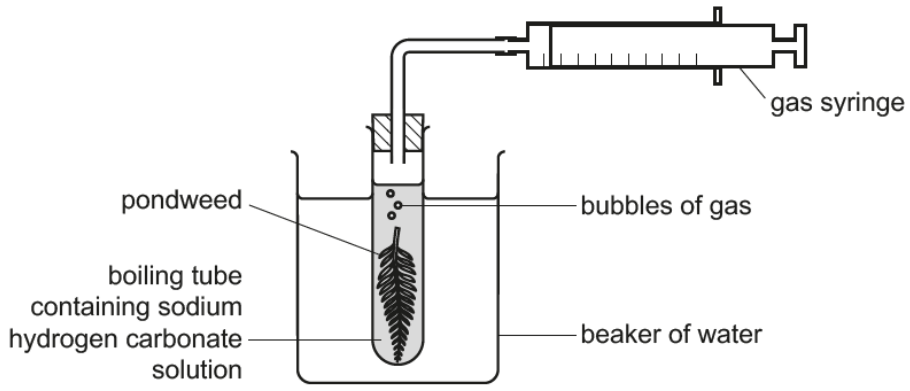

Fig. 1.1

(b) Temperature is the variable that Eve will change.

Write down **one** variable that Eve should control **and** describe how she could control it.

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..... **[2]**

This was generally well answered, although many candidates did not detail how the variable identified should be controlled. A number of candidates gave 'temperature' as the variable despite the question stating that this was the variable that was being changed.

Question 1 (c) (i)

(c) After she has finished the investigation, Eve uses her data to plot the graph in **Fig. 1.2**.

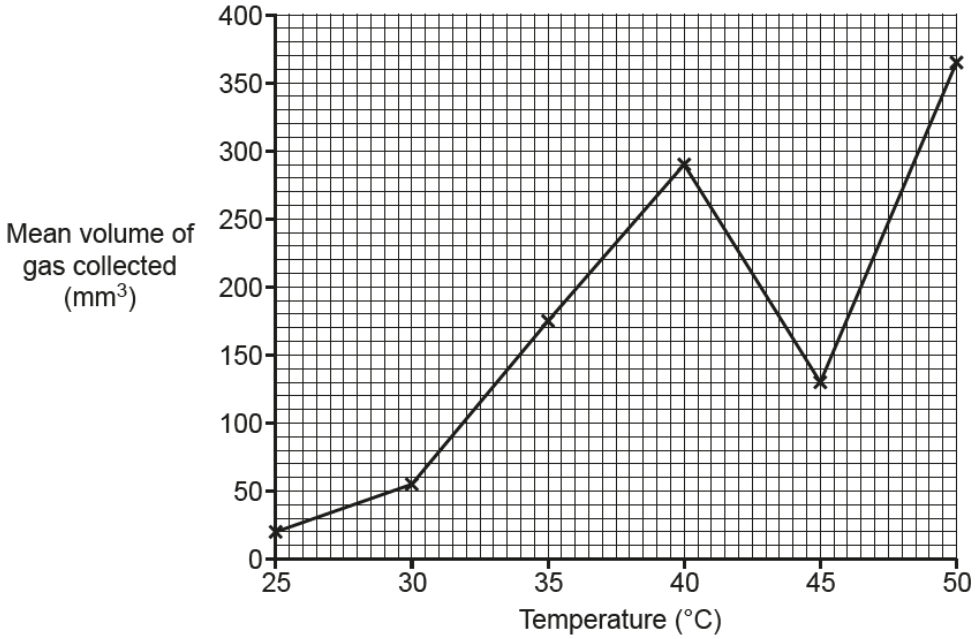

Fig. 1.2

(i) Eve decides to repeat the experiment at 45 °C so that she can take new measurements at this temperature.

Use evidence from **Fig. 1.2** to justify Eve's decision.

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..... **[2]**

This question required the candidates to use evidence from the graph to justify a statement. Candidates were aware of the correct terminology that should be used i.e. 'outlier', 'anomaly'.

Question 1 (c) (ii)

(ii) Here are Eve's new measurements.

Temperature (°C)	Volume of gas collected (mm^3)		
	Repeat 1	Repeat 2	Repeat 3
45	354	360	351

Use Eve's new measurements to complete the graph in **Fig. 1.3**.

You may use the space below for working out.

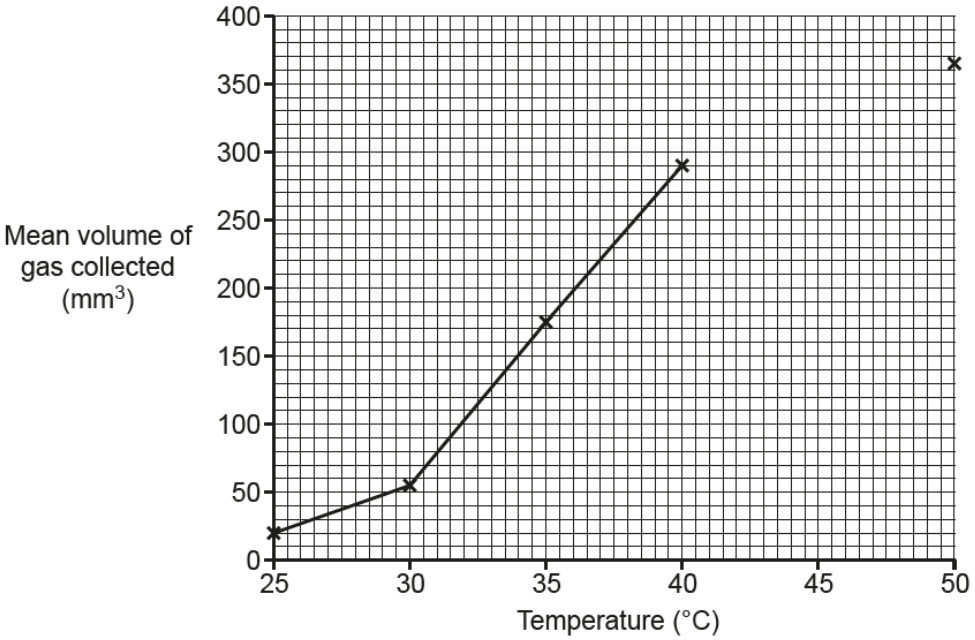

Fig. 1.3

[2]

Most candidates scored both marks available, correctly calculating the mean and plotting the new value. There were a number of incorrect plots, as well as some unclear plots. It must be stressed that a sharp pencil should be used to plot points.

Exemplar 1

$\frac{354 + 360 + 351}{3} = \frac{1065}{3}$

$= 355$

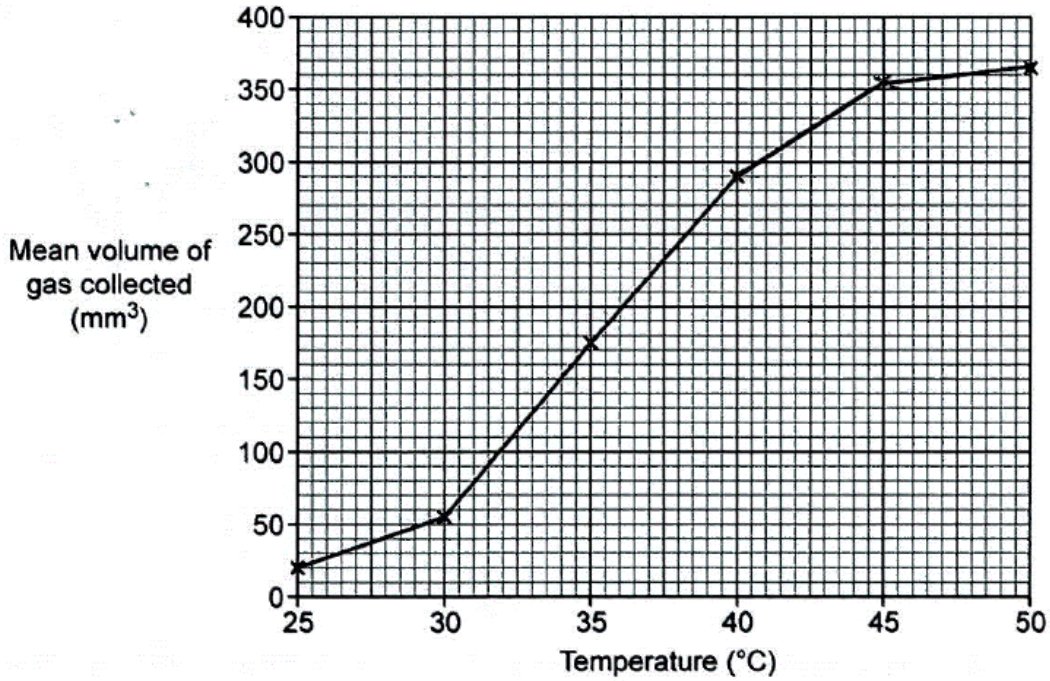

Fig. 1.3

[2]

This answer shows a correct calculation and clear plot.

Question 1 (d)

(d) Describe the trend in the data shown in the graph in **Fig. 1.3**.

Use data from **Fig. 1.3** to support your answer.

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..... **[3]**

In order to score all 3 marks candidates were required to give some detailed reference to data; this was missing from many candidates' responses.

Question 1 (e)

(e) The volume of gas collected changed as the temperature changed.

Calculate the change in volume per degree between 35 °C and 40 °C.

Change in volume per degree = ... $mm^3/°C$ **[2]**

This gave a mixed response with the majority candidates scoring both marks. Many of the remainder of candidates invariably did not use the temperature change and hence did not gain any marks.

Question 2

2* Layla is a doctor. She works with patients in a hospital.

Explain why it is good that Layla does the following things:

- She washes her hands regularly while she is at work.
- Each day she drinks a yogurt drink that contains living bacteria.

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..... **[6]**

Overall most candidates gave Level 3 answers, however many of these candidates did not give an adequate explanation of the benefit of yogurt as a competitor with pathogens instead giving incorrect answers relating to ideas about 'immunity' and hence only accessed the lower end of Level 3.

Exemplar 2

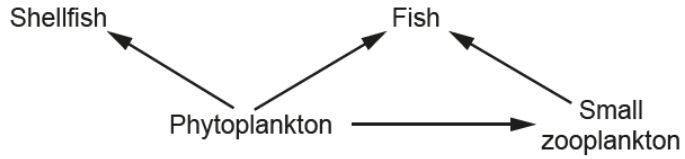
As Layla is a doctor, she works with many sick and diseased patients. These patients may pass on pathogens to Layla's hands when she works with them. Washing her hands will kill the pathogens on her hands preventing her from getting sick. Also, Layla may have pathogens on her hands she washes her hands to kill all the pathogens. As she works with sick patients, they may be more susceptible to diseases, so ~~Lay~~ Layla washes her hands so no pathogens are not passed on to the vulnerable patients. She drinks a yogurt drink containing living bacteria to have a form of bacterial protection. If she ingests any harmful bacteria, the bacteria from her yogurt will compete for resources with the pathogens to survive. The bacteria in the yogurt will protect Layla from diseases as it will stop the pathogens from living and reproducing using food from Layla's body. This prevents her from getting sick and passing on pathogens to others. [6]

This is an example of a good Level 3 answer. The candidate clearly explains why both washing hands and drinking yogurt are good in both general terms and also in the context of the hospital for the consequences to both the doctor and her patients.

Question 3 (a)

3 Plastic pollution in the sea is a big problem.

Look at the food web from the North Sea.



(a) What does the word "Fish" represent in the food web?

Tick (✓) **one** box.

An individual organism ☐

A population ☐

A producer ☐

A species ☐

[1]

This section and the following question part highlighted that candidates seemed to find it challenging to recall definitions. In this part the correct answer of 'population' was only gained by just over half of the candidates.

Question 3 (b)

(b) Explain the difference between a community and an ecosystem using examples from the food web.

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..... **[2]**

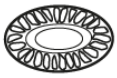
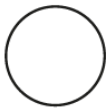
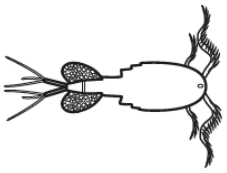
As stated above, candidates found recalling basic ecological definitions difficult with the majority scoring zero.

?	**Misconception**	Community: Many candidates thought that a community only consisted of one species and not all of the interacting populations. Ecosystem: Many candidates did not consider the abiotic aspect.

Question 3 (c)

Plastic litter in the sea breaks down slowly into small pieces called microplastics.

The table gives information about phytoplankton, microplastics and small zooplankton.

	Phytoplankton	Microplastics	Small zooplankton
			
Size	Up to 0.2 mm	Up to 5 mm	Up to 20 mm
Can be digested by fish?	Yes	No	Yes

Fish can eat anything that is less than or equal to 20 mm in size.

(c) Explain why plastic litter in the sea could cause a decrease in the numbers of fish.

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..... **[3]**

Most candidates stated that the microplastics could be eaten but then couldn't be digested. Only some candidates were able to link this to the fish then being unable to gain enough food/nutrients. Instead, candidates gave some incorrect answers suggesting that it would prevent them breathing and general answers concerning 'blockages'.

Exemplar 3

It will cause a decrease in the number of fish because it may be eaten instead of the food the fish would normally eat such as the phytoplankton and small zoo-plankton. However, because it is unable to be digested, the fish would not gain any nutrients from it. The deficient amount of nutrients could then cause the fish to die **[3]**

This response scored 2 marks for the plastic being unable to be digested and the consequential feeding problem.

Question 3 (d) (i)

(d) Scientists have discovered some bacteria in a rubbish dump. These bacteria can break down plastic litter very quickly.

(i) Some people think we should put the bacteria in the North Sea to break down plastic litter.

Suggest and explain how this could put the North Sea ecosystem at even greater risk.

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..... **[4]**

Most marks given for this question were for ideas about the bacteria harming the other organisms and possible effects on the food chain. Candidates found this question challenging.

(ii) Bacteria gaining the ability to break down plastic is an example of evolution.

Explain what changes must have taken place in **the bacteria cells** to give them the ability to break down plastic.

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..... **[2]**

Question 3 (d) (ii)

Many candidates knew that a mutation could be responsible for this. Very few candidates could then link this to the idea that it would produce an enzyme that could digest plastic.

Exemplar 4

A mutation must take place which can then change the sequence of amino acids which then changes the gene and can result to make different proteins that give them that ability. **[2]**

Turn over

Both marks scored in this example.

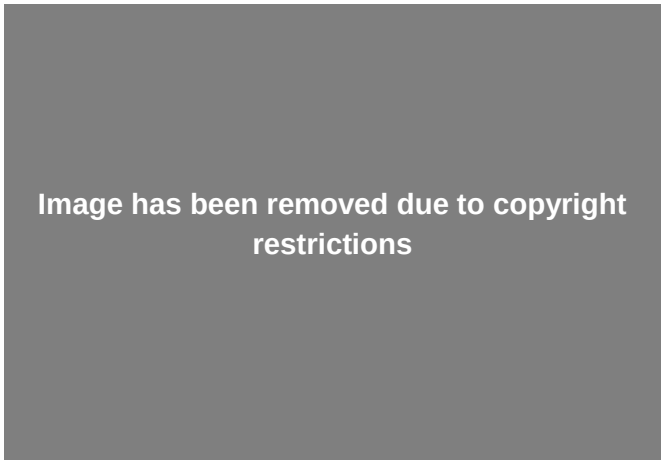
Question 4 (a) (i)

4 Ling and Kai are investigating the stomata of plant leaves.

(a) Ling wants to work out the size of one stoma (one of the stomata of a leaf).

She uses a light microscope to look at the underside of a leaf.

She uses a camera attached to the microscope to take a photograph.



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(i) Complete the labelling of the photograph. **[1]**

Well answered by the majority of candidates.

Question 4 (a) (ii)

(ii) The length of the stoma in Ling's photograph is 15 mm.

The photograph has a magnification of ×400.

Calculate the length of the original stoma.

Give your answer in standard form.

Length = ... mm **[2]**

Again this was well answered with candidates following the instructions to give their answer in standard form.

Question 4 (b) (i)

(b) Kai wants to work out how many stomata are found in each mm^2 of the leaf's surface.

- He paints clear nail varnish onto a small area of the underside of a leaf.
- When the varnish has dried he peels it off using clear sticky tape.
- He sticks the tape onto a microscope slide.

Kai will use a light microscope to count the impressions of stomata in the varnish.

Here is his planned method.

1. Clip the slide on the stage.

2. Rotate the objective lens until it clicks into position above the slide.

3. Place the microscope in direct sunlight and look into the eyepiece lens. Adjust the mirror until the image is as bright as possible.

4. Look into the eyepiece lens and use the coarse focus to move the objective lens towards the slide until the image is in focus.

5. Use the fine focus to move the objective lens away from the slide until the image is as sharp as possible.

Fig. 4.1 shows the light microscope Kai uses.

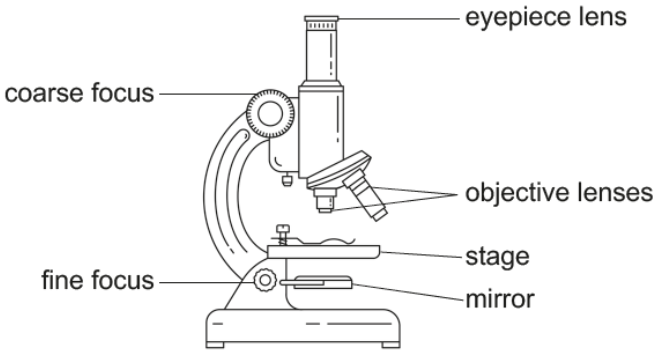


Fig. 4.1

(i) Write down the numbers of **two** steps in Kai's method that have a high risk of causing damage to Kai or the apparatus.

For each of these steps, explain why it is dangerous **and** suggest how to reduce the risk.

step .....

why it is dangerous .....

.....

how to reduce the risk .....

.....

step .....

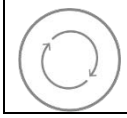
why it is dangerous .....

.....

how to reduce the risk .....

..... **[4]**

Most candidates were able to recognise the potential problems with eye damage and the solution to this. Damage to slide/lens was sometimes given by a few candidates, but the method of reducing the risk was rarely seen.

	**AfL**	When carrying out practical with microscopes, discuss the health & safety issues as well as safe handling of the equipment & specimens.

Question 4 (b) (ii)

(ii) Kai sets up the microscope using a safer method provided by his teacher.

He puts a clear plastic ruler on the stage.

He uses the microscope to look at the millimetre markings on the ruler. **Fig. 4.2** shows what he sees.

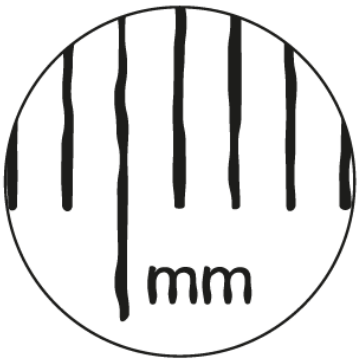


Fig. 4.2

In **Fig. 4.2** the distance between each marking is 1 mm.

Calculate the area of the field of view.

In your calculation, assume $\pi = 3.14$.

Give your answer to **3** significant figures.

Area = ... mm^2 **[3]**

Well answered; the majority of candidates were able to put their answer to the correct number of significant figures. There were a number of candidates that used an incorrect radius but still obtained at least 2 marks because they showed their calculations, enabling error carried forward marks to be given.

Question 4 (b) (iii)

(iii) Kai removes the ruler from the stage and replaces it with the slide showing stomata.

He makes no other changes to the microscope. **Fig. 4.3** shows what he sees.

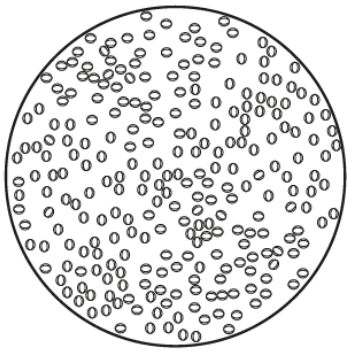


Fig. 4.3

Kai counts 255 stomata in the field of view.

Estimate the density of stomata (how many are found in each mm^2) in this field of view.

Density = ... stomata per mm^2 **[1]**

Most candidates were given the mark, however there were a number of candidates who used an incorrect value of 225 stomata in their calculation.

Question 4 (b) (iv)

(iv) Suggest why the density of stomata in this field of view may **not** be the same as the density of stomata over the whole leaf surface.

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..... **[2]**

Most candidates scored one mark for realising that the density of stomata would vary across the leaf, but very few linked this to the small sample area.

Question 4 (c)

(c) Explain the advantages **and** disadvantages for a plant of opening its stomata.

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..... **[4]**

Candidates found this question challenging. Many candidates realised that gas exchange was involved but either did not give the processes concerned or gave the wrong gases involved.

?	**Misconception**	Some candidates could not correctly identify what entered through stomata, indicating that substances such as water, minerals and sunlight entered.

~~When~~ An advantage is that when the stomata are open, gas exchange can occur meaning that carbon dioxide can be taken in for photosynthesis which is used by the plant to make glucose for different purposes within the plant. ~~One~~ Opening them also means that ~~they will not~~ concentration of water will not get too high as water is lost through the stomata during transpiration. A disadvantage of opening its stomata is that water can be lost through them ~~&~~ leaving the plants with too little water if the area is too dry for them (e.g. if there has been a drought). **[4]**

Exemplar 5

This example correctly identifies one process, including one of the correct gases and direction of movement as well as a disadvantage of water loss and so scores 2 out of 4 marks.

Question 5 (a) (i)

5 Smoking cigarettes is linked to lung cancer.

(a) The National Health Service (NHS) in England helped 196 000 people who wanted to stop smoking in 2017.

(i) After using the NHS, 98 000 of these people told their doctor they had stopped smoking.

What percentage of the people who used the NHS said they had stopped smoking?

Percentage of people = ... % **[1]**

Calculation correctly performed by the majority of candidates.

Question 5 (a) (ii)

(ii) Doctors tested the breath of all the people who said they had stopped smoking.

The tests showed that 72% of these people really had stopped smoking.

How many people had successfully stopped smoking?

Number of people = ... people **[1]**

Calculation correctly performed by the majority of the candidates.

Question 5 (b)

(b) Cigarette smoke contains carcinogens.

Carcinogens are substances that can cause mutations in a cell's DNA.

Explain how this can lead to cancer.

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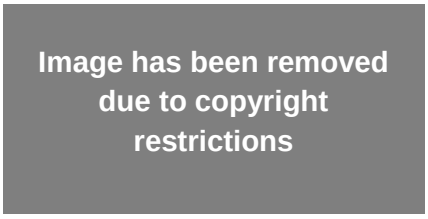
..... **[3]**

The term 'tumour' was widely used, however many candidates did not gain credit as they gave a very general response; saying the definition of a mutation but then not linking this to an explanation of how a mutation can lead to cancer occurring.

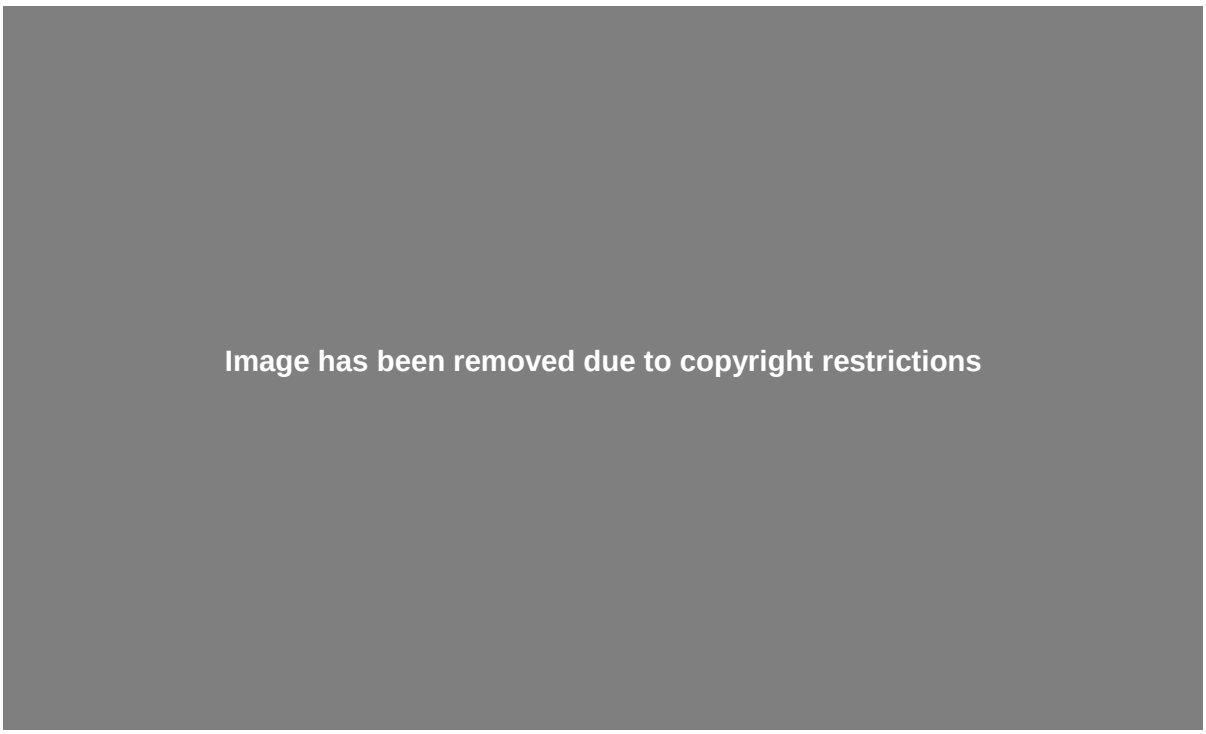
Question 5 (c) (i)

(c) Some people who want to stop smoking cigarettes start using e-cigarettes (vaping) instead.



Cigarette smoke and e-cigarette vapour both contain carcinogens called NNK, benzene and acrolein.

Scientists measured the concentrations of these carcinogens in the saliva and urine of three groups of people. The groups had behaved in different ways for six months.



(i) The mean concentration of NNK for Group 1 was 53 pg/mg
The mean concentration of NNK for Group 3 was 1 pg/mg.

Calculate the percentage change in the mean concentration of NNK in Group 3 compared to Group 1.

Percentage change = ... % **[2]**

1 mark was given in the majority of cases as candidates did not realise the answer should be a negative value.

Question 5 (c) (ii)

(ii) Read the news headline:

E-cigarettes 98% safer than cigarettes

Do you agree with the headline? Explain your answer.

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..... **[2]**

Many candidates scored one mark for realising that only NNK had been reduced by 98%, but then did not give details that the other two carcinogens had not been reduced by this amount.

Question 5 (c) (iii)

(iii)* Beth is worried because her mother and sister both died from lung cancer.

She plans to reduce the number of cigarettes she smokes and she will use an e-cigarette the rest of the time.

Describe the factors that affect Beth's risk of developing lung cancer **and** explain the best course of action for her.

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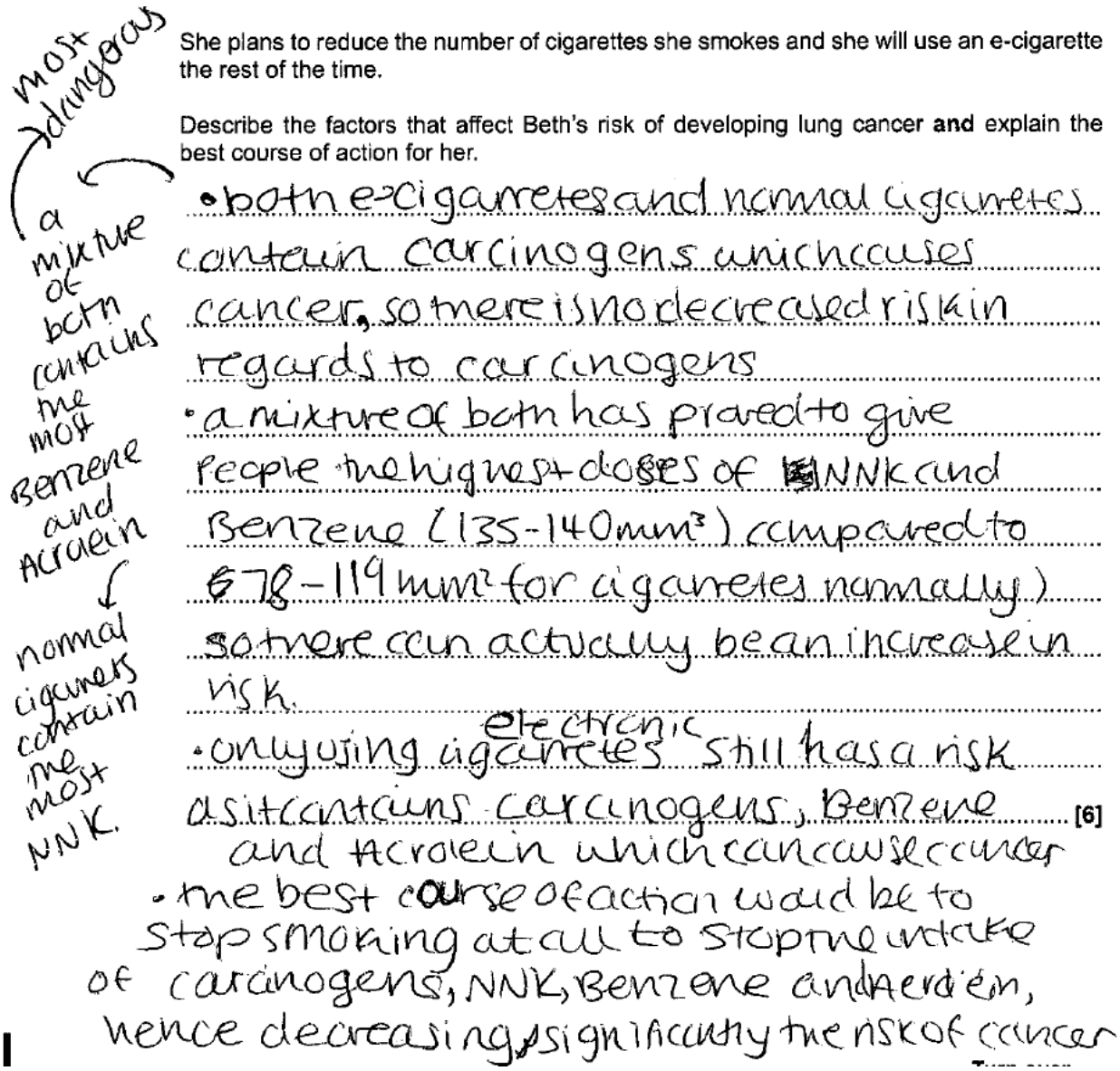
..... **[6]**

Candidates generally scored well on this level of response with the majority being given at least a higher Level 2 / Level 3 mark. For those who did not gain a higher Level 3 mark, reference to the genetic component was missed and there were many less relevant statements made about diet, exercise and the need to have 'tests'.

Exemplar 6



most dangerous

a mixture of both contains the most Benzene and Acrolein

normal cigarettes contain the most NNK.

She plans to reduce the number of cigarettes she smokes and she will use an e-cigarette the rest of the time.

Describe the factors that affect Beth's risk of developing lung cancer **and** explain the best course of action for her.

- both e-cigarettes and normal cigarettes contain carcinogens which causes cancer, so there is no decreased risk in regards to carcinogens
- a mixture of both has proved to give people the highest doses of NNK and Benzene (135-140nm³) compared to 678-119 nm² for cigarettes normally) so there can actually be an increase in risk.
- only using electronic cigarettes still has a risk as it contains carcinogens, Benzene and Acrolein which can cause cancer [6]
- the best course of action would be to stop smoking at all to stop the intake of carcinogens, NNK, Benzene and Acrolein, hence decreasing significantly the risk of cancer

A good Level 2 response, but it did not take account of the genetic link implied in the first line of the question.

Question 6 (a) (i)

6 Red blood cells carry oxygen.

(a) Red blood cells are made from adult stem cells in the bone marrow.

(i) A stem cell divides by mitosis to make red blood cells.

Mitosis is one stage of the cell cycle. The other stage is interphase.

Complete the table to describe three things that happen during each stage of the cell cycle.

Interphase	Mitosis
1 The cell grows larger	1
2	2 The nucleus divides
3	3 The cell divides

[3]

Candidates found this question aimed at recall of biology challenging.

?	**Misconception**	A common mistake indicating that 'splitting' takes place in mitosis, whereas 'separation' is required.

Question 6 (a) (ii)

(ii) Explain how a stem cell is able to become a different type of cell.

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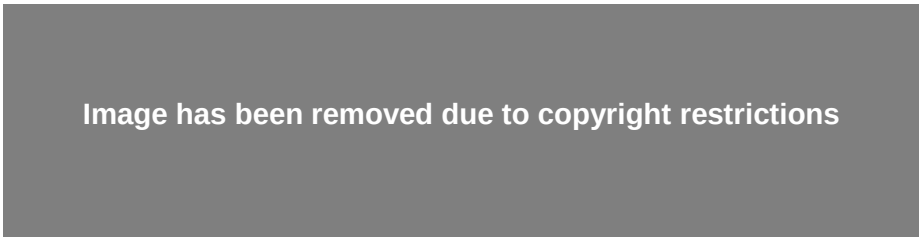
..... **[3]**

Most candidates knew that stem cells were undifferentiated. The other 2 marks were rarely given due to a lack of detail about genes switching on and off and the production of specialised cells.

Question 6 (b)

Sickle-cell disease affects the shape of red blood cells.

(b) Look at the picture of red blood cells.



Explain why people with sickle-cell disease often have difficulty in getting enough oxygen to their body tissues.

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..... **[3]**

The function of red blood cells was generally well known and some candidates gained marks relating to haemoglobin being responsible for carrying oxygen. There was, however, great confusion with the terms surface area and volume. Many candidates did not link the reduced surface area to rates of absorption.

Question 6 (c) (i)

(c) Sickle-cell disease is common in regions of the world in which malaria is also common.

Read the information about sickle-cell disease and malaria.

> Sickle-cell disease is caused by a faulty allele. It causes pain from a young age but average life expectancy with the disease is 40 to 60 years.
>
> Only people who are homozygous for the sickle-cell allele have sickle-cell disease.
>
> People who are heterozygous do not have sickle-cell disease, and also have some resistance to malaria.
>
> People who are homozygous for the normal allele do not have sickle-cell disease and have no resistance to malaria.
>
> Malaria can be fatal.

(i) Use the information to explain why sickle-cell disease is common in regions in which malaria is widespread.

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..... **[5]**

Many candidates merely rewrote the information from the question stem. In addition, there was confusion as to which genotypes would have sickle-cell disease or would have resistance to malaria. A number of candidates also thought that malaria was an inherited condition.

Question 6 (c) (ii)

(ii) Suggest why sickle-cell disease would be less common in these regions if malaria was wiped out.

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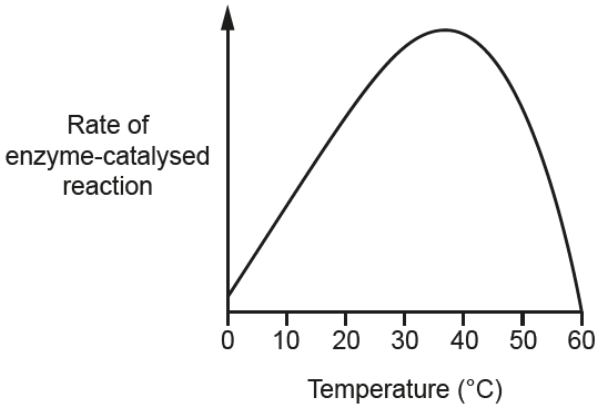
..... **[2]**

The stated confusion in part (i) continued here and some incorrect reasoning was given, such as sickle-cell disease was no longer an advantage or that it wasn't needed any more.

Question 7 (a) (i)

7 Enzymes catalyse reactions in living organisms.

(a) The graph shows how the activity of a human enzyme changes as the temperature changes.



(i) Use the graph to explain why it is important for the human body to maintain a constant internal temperature of 37 °C.

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..... **[3]**

Generally well answered, candidates' knowledge of enzymes appeared to be good, although a common misconception was that the cold temperatures would lead to the enzymes denaturing.

Question 7 (a) (ii)

(ii) Scientists have found single-celled organisms called thermophiles living around hot vents on the sea floor.

Thermophiles cannot control their temperature. The cell and its contents are the same temperature as the seawater.

The temperature of the seawater around one hot vent is 50 °C.

Suggest **and** explain how you would expect the graph to look for an enzyme from a thermophile living around this vent.

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..... **[2]**

The first mark point about the optimum temperature of the peak of the thermophile enzymes being at 50°C was well answered however the second mark about this being an adaptation was rarely seen.

Question 7 (a) (iii)

(iii) The seawater around the vent has a very high concentration of salt.

Describe **and** explain how this could affect the single-celled thermophiles.

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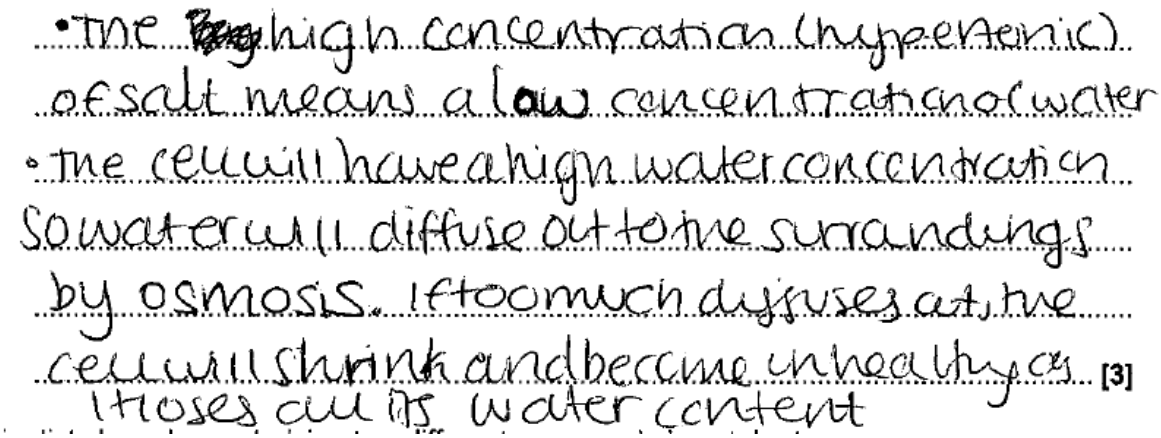
..... **[3]**

The candidates with a good understanding of osmosis scored well here, however many candidates were under the impression that the salt would move into the cells by osmosis and that the enzyme activity would be compromised by the salt.

Exemplar 7


• The high concentration (hypertonic) of salt means a low concentration of water
• the cell will have a high water concentration so water will diffuse out to the surrandings by osmosis. If too much diffuses at the cell will shrink and become unhealthy as it loses all its water content [3]

This example correctly showed knowledge of osmosis and how this would affect the thermophile in this situation.

Question 7 (b)

(b) Scientists have been studying two different enzymes in invertebrates.

- Both enzymes break down the same substrate.
- The shape of the active site of each enzyme is the same.
- Each enzyme is coded for by a different gene.
- There are some differences in the sequences of bases in the two genes because of mutations.

Explain how the two enzymes could have the same shaped active site when they are made from genes with differences in their base sequences.

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..... **[4]**

Many answers merely re-stated part of the question that the enzymes would have the same active site as they break down the same substrate. There were a few marks given for the idea that different sets of three bases can code for the same amino acid however the ideas that the mutation may affect the enzyme away from the active site was not considered.

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