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GCSE (9-1)

Examiners' report

TWENTY FIRST CENTURY SCIENCE BIOLOGY B

J257

For first teaching in 2016

J257/04 Summer 2022 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. A selection of candidate answers are also provided. 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 and the mark scheme can be downloaded from OCR.

Advance Information for Summer 2022 assessments

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our website.

Paper 4 series overview

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

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 Level of 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 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, some candidates had problems with certain aspects of Questions 4, 5 & 7 which are detailed in the next section.

Most candidates used the spaces provided for their responses; however some extended their answers to the additional pages. Where candidates were not able to limit their answers to the provided space and used the extra examination sheets, it should be stressed to them that it is very important to clearly show the question numbers.

This cohort has experienced significant disruption to their learning due to the pandemic. The extent to which this will have affected each candidate will be different and will depend on the quantity and quality of provision during lockdown as well as the duration of time each candidate was out of school. The exposure that candidates had to practical activities will also be different and may have been limited to observing demonstrations.

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
• answered the mathematical questions well. • referred to all instructions in the Level of Response questions. • were aware of all processes involved in the vaccination process.	• confused the processes of respiration & photosynthesis.

Question 1 (a)

1 The pupil of the human eye changes size in different light levels.

(a) A diagram of the eye is shown in **Fig. 1.1**.

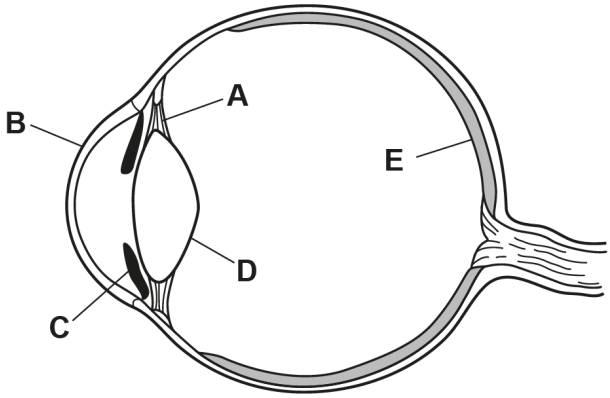

Fig. 1.1

Which structure in the eye changes the size of the pupil?

Tick (✓) **one** box.

A Ciliary muscles ☐

B Cornea ☐

C Iris ☐

D Lens ☐

E Retina ☐

[1]

Almost half of candidates, were unsure which structure was responsible for changing the size of the pupil.

Question 1 (b)

(b) The pupil changing size is a reflex action that happens in response to light. It uses a reflex arc in the nervous system.

The pupil reflex arc includes a sensory neuron that connects the eye to the spinal cord.

State **two other** types of neurons that must be part of the pupil reflex arc.

1 .....

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

Well answered, the majority of candidates were aware of the neurons involved in the reflex arc.

Question 1 (c) (i)

(c) Ali plans to investigate the effect of light brightness on the diameter of the pupil of a person's eye.

The method Ali plans to use is shown in **Fig. 1.2**.

1. Shine a bright light into the person's eye.
2. Hold a ruler up to their eye and measure the diameter of the pupil.
3. Repeat with light at a different brightness.

Fig. 1.2

Ali's teacher says that Ali's method is not safe and could damage the person's eye.

(i) Identify the structure in the person's eye that could be damaged by step **1**, and suggest why the damage would affect the person's vision.

Structure that could be damaged .....

Why this would affect the person's vision .....

.....

.....

[2]

The structure involved was known by the majority of candidates, however details of its function was less well answered.

Question 1 (c) (ii)

(ii) Identify the structure in the person's eye that could be damaged by step **2**, and suggest why the damage would affect the person's vision.

Structure that could be damaged .....

Why this would affect the person's vision .....

.....

.....

[2]

In a similar way to the previous question, structure was known but some candidates merely repeated the stem of the question and stated that 'the cornea would be damaged' and did not relate to how this would affect the person's vision.

Question 1 (d) (i)

(d) A scientist uses a safer method to collect the data as shown in the graph in **Fig. 1.3**.

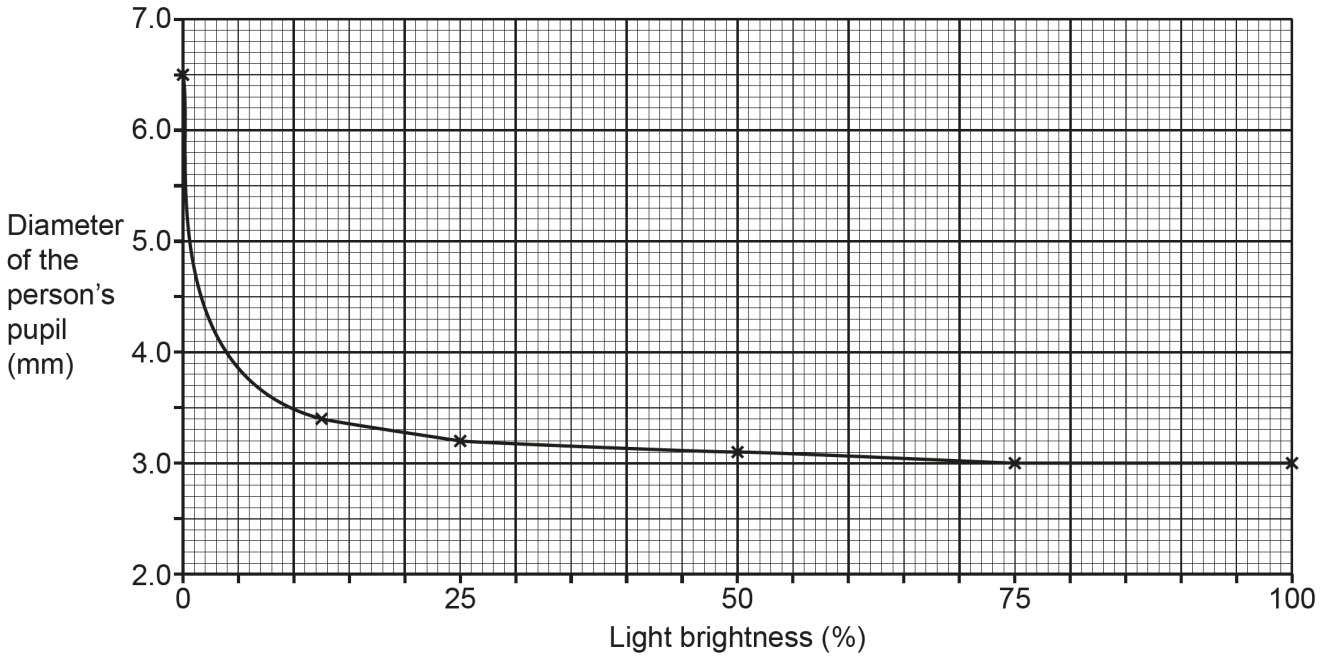

Fig. 1.3

Use **Fig. 1.3** to answer the following questions.

(i) What was the diameter of the person's pupil in complete darkness?

Diameter = ... mm **[1]**

The majority of candidates interpreted the graph very well.

Question 1 (d) (ii)

(ii) What would you conclude is the smallest possible diameter of the person's pupil?

Explain your answer.

Smallest possible diameter = ... mm

Explanation .....

.....

[2]

This question was answered well.

Question 1 (d) (iii)

(iii) Calculate the rate at which the pupil diameter changed between 25% and 50% light brightness.

Rate = ... mm / % **[2]**

Candidates had some difficulty reading the values from the graph. There were some who also gave their response as a fraction.

Question 1 (e)*

(e)* Describe a method that can be used to collect the data shown in **Fig. 1.3**.
Assume that 100% light brightness is a normally lit room.

In your answer you should describe:

- how you would safely change the light brightness and measure the results
- things you would do or control to make sure the measurements are as accurate as possible.

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

A little under a quarter of of candidates were given a Level 3. Many responses did not fully engage with the question and did not address how to safely measure the diameter of the pupil, still stating that they would use a ruler and not stating a method of how they would change and measure the brightness of the lights.

Exemplar 1

You should place a patient in a dark (0% light room) by ensuring all light sources are blocked (e.g window, door etc) Then you will place a lamp facing slightly away from the patient to ensure their eye isn't damaged. You should then slowly increase the light brightness of the lamp whilst simultaneously taking pictures of the eye (don't use flash as would corrupt results). Once progressed to 100% light brightness, you will look at the data and plot in on a graph (as shown in FIG 1.3) You would take the data 3 times in order to find a mean average before plotting the graph, in order to get the most accurate results possible. [6]

This response gives a good method of safely measuring the diameter of the pupil and several examples of increasing the accuracy and safety but does not give a method of changing the light brightness to specific levels so is give Level 2 - 4 marks.

Question 2 (a)

2 *Elysia* sea slugs are very unusual animals.

(a) The sea slugs eat algae. The slugs take chloroplasts from the algae cells. The chloroplasts stay inside the slugs and continue to work.

Suggest why it is an advantage to a sea slug to have working chloroplasts in its body.

.....

.....

.....

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

Many candidates did not recognise the link between chloroplasts and photosynthesis, hence allowing the sea slugs to be able to make its food. Another area of concern was the terminology used when referring to energy. Terms such as creating and making energy were given in some responses and some candidates were also confused between photosynthesis and respiration.

Question 2 (b) (i)

(b) When a sea slug's body is attacked by predators, its head can separate from the body.

The head continues to live and grows a new body. All of the different tissues and organs for the slug's new body grow from a particular type of cell.

(i) From which type of cell must the slug's new tissues and organs grow?

Put a (ring) around the correct answer.

Gametes **Meristem** **Nerve cells** **Stem cells**

[1]

Well answered, most candidates were aware of the type of cell involved.

Question 2 (b) (ii)

(ii) Explain how these cells make tissues and organs for the slug's new body.

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.....

.....

.....

.....

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

Most candidates knew that stem cells could become differentiated but responses tended to lack developed explanation.

Question 3 (a)

3 Gentoo penguins live on islands near South America.

(a) The number of Gentoo penguins on the islands is decreasing.

Suggest **one** factor that could have caused the decrease in the number of Gentoo penguins.

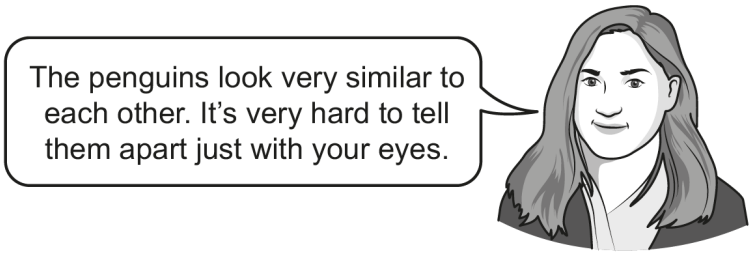
.....

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

Well answered, most candidates were able to suggest a suitable factor to explain the decrease in the number of penguins.

Question 3 (b)

(b) Scientists used to think all the Gentoo penguins were the same species.



New evidence suggests that there are four different species of Gentoo penguins.

Describe evidence that scientists could have collected from the penguins' cells to show that there are four different species.

.....

.....

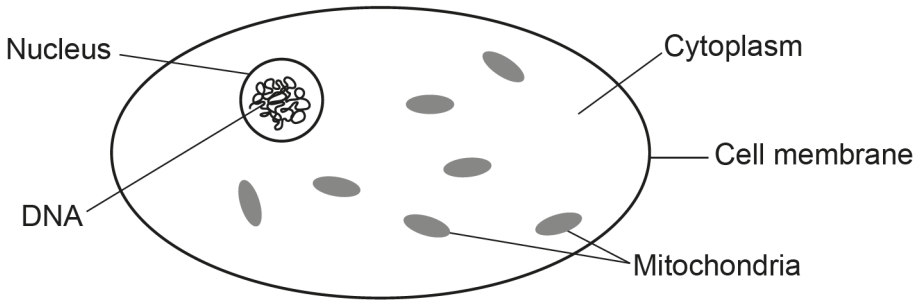
.....

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

The majority of answers recognised that it would be differences in the penguins' DNA that would show that there were different species.

Question 3 (c)

(c) The diagram shows a cell from a Gentoo penguin.



The presence of mitochondria shows that this is a eukaryotic cell.

Which other structure shows that this is a eukaryotic cell?

Tick (✓) **one** box.

- Cell membrane ☐
- Cytoplasm ☐
- DNA ☐
- Nucleus ☐

[1]

Most candidates gave the correct response – nucleus.

Question 3 (d)

(d) If a cell contains a vacuole, this suggests it could be a plant cell.

State **one other** structure that suggests a cell is a plant cell.

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

The correct plant cell structures were given by most candidates.

Question 3 (e)

(e) The length of a cell is 0.00002 m.

How is the length of the cell written in standard form?

Put a (ring) around the correct answer.

2×10^{-5} m **2×10^{-4} m** **2×10^{4} m** **2×10^{5} m**

[1]

Most candidates were capable of converting the length to standard form.

Question 3 (f)

(f) The length of a mitochondrion is 3×10^{-6} m.

What is another way to write the length of the mitochondrion?

Put a (ring) around the correct answer.

0.0003 m **0.00003 m** **0.000003 m** **0.0000003 m**

[1]

Likewise, the reverse process was well answered.

Question 4 (a) (i)

4 Bacteria can become resistant to antibiotics.

(a) Charlie investigates whether a type of bacteria can grow in different antibiotics.

- Charlie uses aseptic techniques to add a drop of liquid containing the bacteria to the centre of each of four Petri dishes.
- Each Petri dish already contains a different antibiotic.
- The four Petri dishes are incubated for 24 hours.

The appearance of the four Petri dishes after incubation is shown in **Fig. 4.1**.

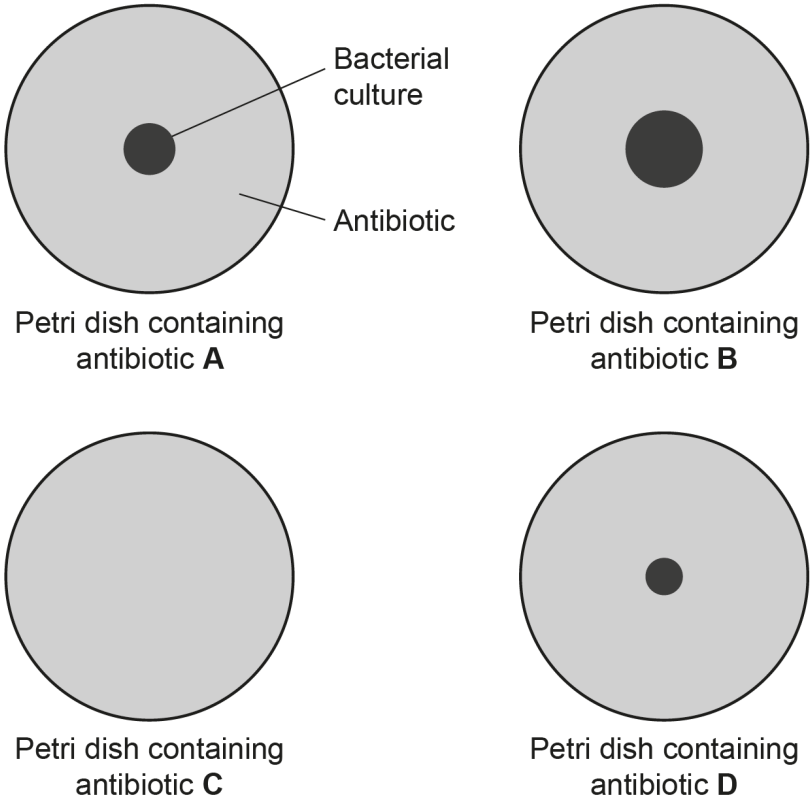


Fig. 4.1

(i) In the Petri dish containing antibiotic **B**, the bacterial culture has a radius (r) of 5 mm.

Calculate the area of the bacterial culture in this Petri dish.

Use the equation: area = $3.14 \times r^2$

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

This calculation was successfully carried out by the majority of candidates gaining both marks.

Question 4 (a) (ii)

(ii) Which antibiotic would be the **best** choice to treat a sick patient who was infected with this type of bacteria?

Describe the evidence in **Fig. 4.1** that supports your choice.

Antibiotic .....

Evidence .....

.....

.....

.....

[3]

Most candidates achieved 2 marks here, recognising the correct petri dish having the least/no bacteria remaining, however without relating this to resistance to the other antibiotics they cannot be given the third mark. This question also possibly highlighted a problem of some candidates not having had the experience of observing this practical and giving petri dish B as the one that was the best choice for treating a sick patient.

Question 4 (b) (i)

(b) **Fig. 4.2** shows the number of infections (rounded to the nearest 100) with antibiotic-resistant bacteria in England over four years.

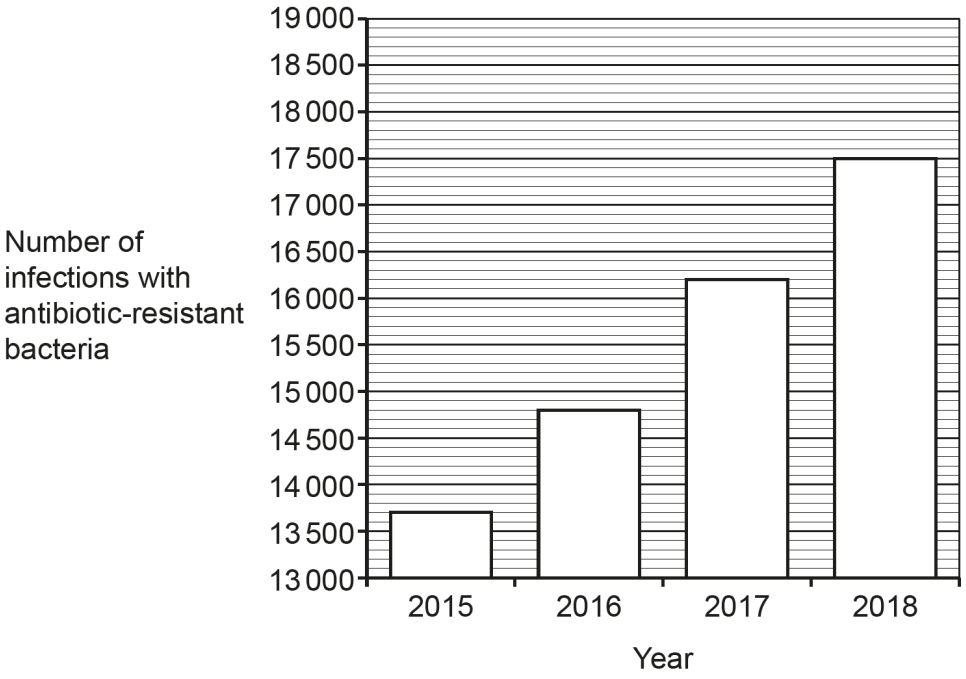


Fig. 4.2

(i) Calculate the percentage increase in the number of infections with antibiotic-resistant bacteria from 2017 to 2018.

Give your answer to **1** significant figure.

Percentage increase = ... % **[3]**

The majority of candidates calculated the correct percentage increase and correctly gave their answer to 1 significant figure.

Question 4 (b) (ii)

(ii) Predict what the number of infections with antibiotic-resistant bacteria might have been in 2019.

Explain your answer.

Prediction .....

Explanation .....

.....

.....

[3]

Once again mathematical processing was well answered.

Question 4 (c) (i)

(c) A bacterium can become resistant to an antibiotic if it receives a plasmid from another bacterium.

(i) Explain what a plasmid is.

.....

.....

.....

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

Many candidates were unaware of what a plasmid is and very few knew that it was additional to a bacterial chromosome.

Question 4 (c) (ii)

(ii) Explain how receiving a plasmid causes a bacterium to become resistant to an antibiotic.

.....

.....

.....

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

As with the first part to this section candidates' knowledge of plasmids and how they can cause bacterial resistance was less successfully answered.

Question 4 (c) (iii)

(iii) Explain how a bacterium could become resistant to an antibiotic **without** receiving a plasmid.

.....

.....

.....

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

Most candidates were aware that a mutation could also be responsible for bacterial resistance.

Question 5 (a) (i)

5 Photosynthesis takes place in plants.

(a) Starch is a carbohydrate that is made when a plant photosynthesises.

Sam investigates the effects of different conditions on the presence of starch in three plant shoots. All three plants are given plenty of water throughout the experiment.

The method Sam uses for the experiment is shown in **Fig. 5.1**.

1. Keep three plant shoots in a dark place for two days.
2. **Test 1:** Cut a small piece of leaf tissue from each plant **A**, **B** and **C**. Test the pieces of leaf tissue for starch.
3. Wrap the leaf of plant **B** in metal foil.
4. Put the leaf of plant **C** inside an open conical flask containing potassium hydroxide solution to absorb carbon dioxide.
5. Keep the three plant shoots in bright light for one day.
6. **Test 2:** Cut a small piece of leaf tissue from each plant. Test the pieces of leaf tissue for starch.

Fig. 5.1

Fig. 5.2 shows the plants during step 5 of Sam's method.

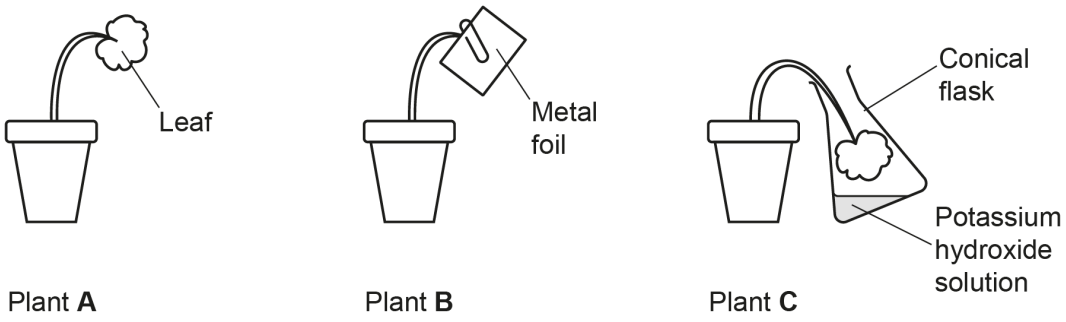


Fig. 5.2

Some of Sam's results are shown in **Table 5.1**.

Plant	Result of test 1	Result of test 2
A	Reagent appeared light brown	
B	Reagent appeared light brown	Reagent appeared light brown
C	Reagent appeared light brown	

(i) State the name of the reagent used to test for starch.

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

Many candidates knew that iodine was the reagent used for testing for starch.

Question 5 (a) (ii)

(ii) Describe a conclusion that can be made from the result of test **2** for plant **B**.

.....

.....

.....

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

The key to this part was recognising the positive and negative result with the iodine / starch test and then relating this to the experiment.

Question 5 (a) (iii)

(iii) Predict the result of test **2** for plant **A**.

Explain your prediction.

Prediction .....

.....

Explanation .....

.....

[3]

This was well answered with the majority of candidates being given at least 2 of the 3 marks. The third mark was only given to the more successful candidates who recognised that both light and carbon dioxide were required for photosynthesis.

Question 5 (a) (iv)

(iv) Stores of starch can be broken down to make glucose.

Suggest how this helps to explain the result of test **1** for plant **A**.

.....

.....

.....

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

This question was less successfully answered, very few candidates realised that the starch would be broken down to glucose for respiration.

Question 5 (a) (v)

(v) Suggest why it is helpful to keep the three plants in the dark for two days at the start of the experiment (step 1).

.....

.....

.....

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

The more successful candidates realised and were able to explain that this provided the same starting point for all three tests so the effects of the different conditions could be explained.

Question 5 (a) (vi)

(vi) Sam predicts that test **2** for plant **C** would show **no** starch was present. However, the test shows that starch **is present**.

Describe **and** explain **one** improvement to their method that would produce the result Sam predicted for test **2** for plant **C**.

.....

.....

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

There was some confusion about the role of Potassium hydroxide in photosynthesis experiments, however about one quarter of the candidates were given both marks.

Question 5 (b) (i)

(b) A tank of water containing living pondweed is placed next to the window. Pondweed is a plant that lives in water.

Fig. 5.3 shows how the amounts of oxygen and carbon dioxide in the water changes over 24 hours.

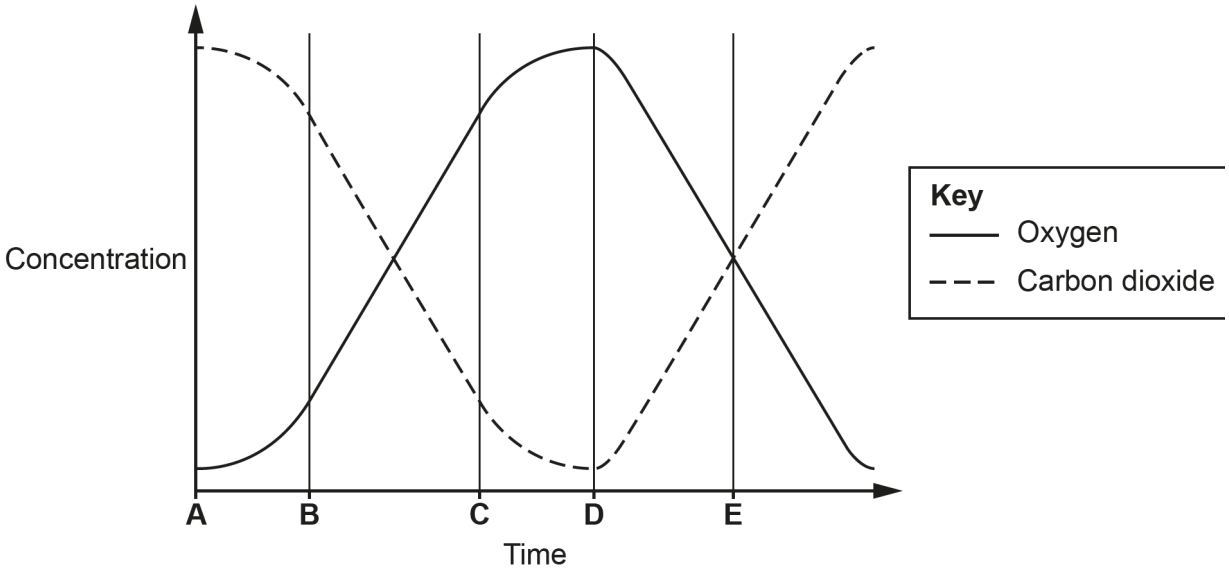


Fig. 5.3

Five time points in **Fig. 5.3** have been labelled **A**, **B**, **C**, **D** and **E**.

(i) At which time point were the concentrations of oxygen and carbon dioxide exactly the same?

Time point ..... **[1]**

This question was well answered by most candidates.

Question 5 (b) (ii)

(ii) Between which **two** time points is the line for oxygen represented by the equation $y = mx + c$?

Time points ..... and ..... **[1]**

Most candidates recognised that this is the equation for a straight line and correctly gave the time points B & C.

Question 5 (b) (iii)

(iii)* A student concludes that time point **D** is sunset.

Describe **and** explain how **Fig. 5.3** supports the student's conclusion.

.....

.....

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.....

.....

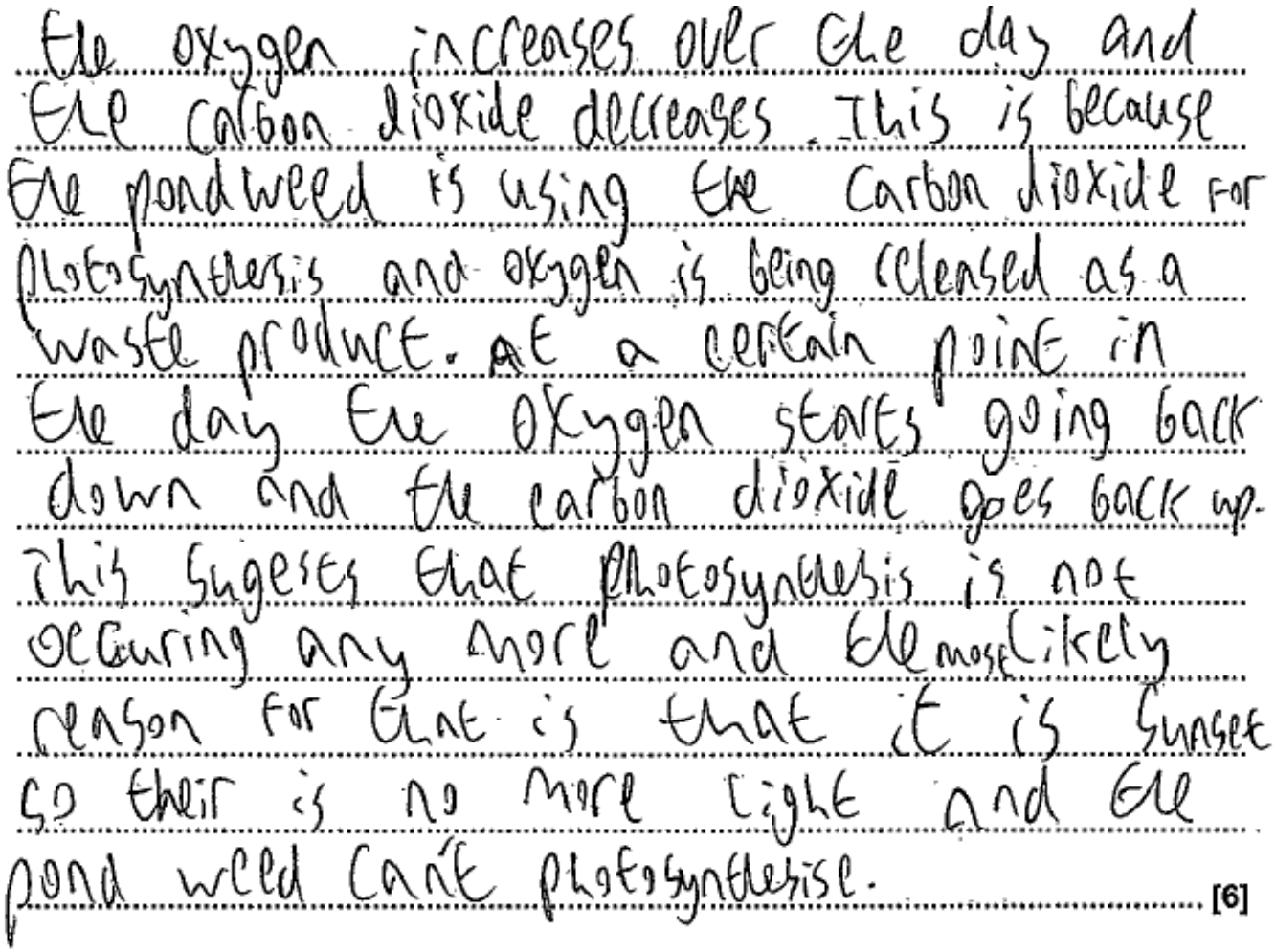
..... **[6]**

There were a number of misconceptions here. Some candidates thought that the highest light intensity was at sunset and thought that the peak of oxygen / trough of carbon dioxide signified maximum rate of photosynthesis at that point. There was little awareness that respiration takes place during the day, seeming to just think that it's either photosynthesis or respiration but not both.

Misconception

Plants carry out respiration all the time.

Exemplar 2

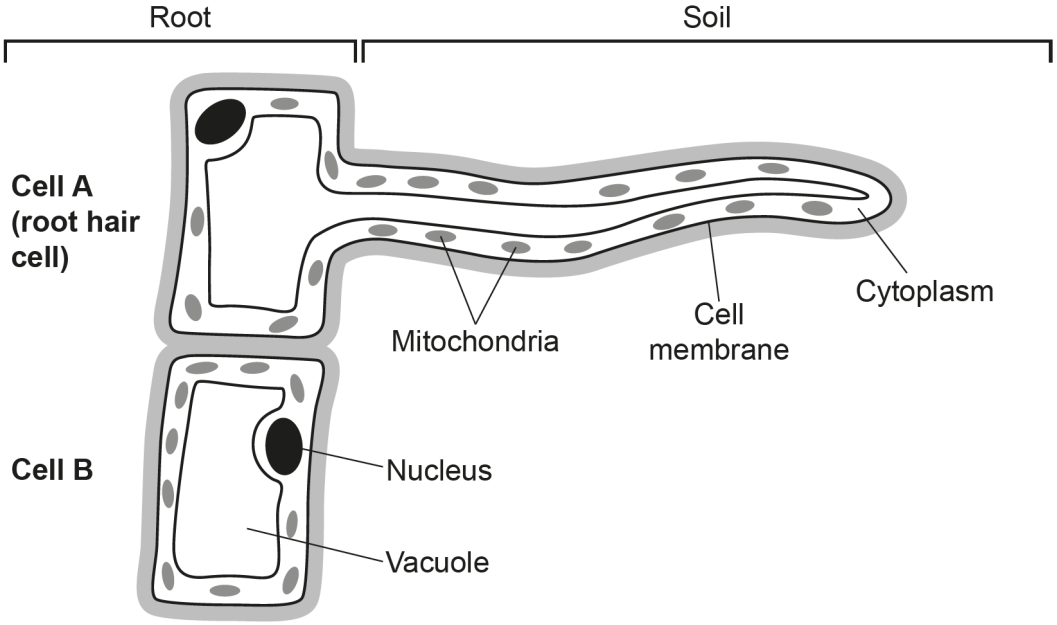

The oxygen increases over the day and the carbon dioxide decreases. This is because the pondweed is using the carbon dioxide for photosynthesis and oxygen is being released as a waste produce. At a certain point in the day the oxygen starts going back down and the carbon dioxide goes back up. This sugests that photosynthesis is not occuring any more and the most likely reason for that is that it is sunset so their is no more light and the pond weed can't photosynthesise. [6]

This response discusses the change in carbon dioxide & oxygen levels and relates them to photosynthesis and light intensity but does not then go on to discuss why the levels change due to respiration, hence a Level 2 - 4 marks.

Question 6 (a)

6 Plants that grow in soil absorb water and nitrate ions through their roots.

Two cells from the outside edge of a root are shown in the diagram.



(a) Which statement explains why the cell membrane of the root hair cell is described as "partially permeable"?

Tick (✓) **one** box.

- Both water molecules and nitrate ions can diffuse through the membrane. ☐
- Neither water molecules nor nitrate ions can diffuse through the membrane. ☐
- Only the nitrate ions can diffuse through the membrane. ☐
- Only the water molecules can diffuse through the membrane. ☐

[1]

Many candidates were under the misapprehension that nitrates as well as water could diffuse through the membrane.

Question 6 (b)

(b) Explain how water molecules are absorbed into the root hair cell from wet soil.

.....

.....

.....

.....

.....

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

Most candidates knew that the water was absorbed through the process of osmosis due to the concentration gradient but did not say that it was passive or that it was a net movement.

Question 6 (c)

(c) Explain how nitrate ions are absorbed into the root hair cell from the soil.

.....

.....

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.....

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

The more successful candidates that knew that active transport was responsible were also given the second mark for recognising that ATP was required but very few connected this with the diagram showing the large numbers of mitochondria in the cell.

Question 6 (d)

(d) Explain why the structure of cell **A** means it is better than cell **B** at absorbing substances from the soil.

.....

.....

.....

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

Most candidates gave the correct comparative response of larger surface area.

Question 7 (a) (i)

7 Scientists are developing new vaccines against human diseases such as influenza.

(a) New vaccines must be tested before they can be approved for widespread use in the population.

(i) New vaccines are tested in pre-clinical trials before they are tested in humans.

Describe **two** ways in which a new influenza vaccine could be tested in **pre-clinical** trials.

.....

.....

.....

.....

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

The majority of candidates were given marks for with 'testing on animals' but did not mention 'cultured' when referring to testing on 'cells'.

Question 7 (a) (ii)

(ii) The next stage of testing involves clinical trials in human volunteers.

A new **medicine** is usually tested in two groups of people. First, it is tested in:

- Group 1: Healthy people who do **not** have the disease.

Then it is tested in:

- Group 2: People who have the disease.

Suggest why a new **vaccine** is tested in group 1 but **not** in group 2.

.....

.....

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.....

.....

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

The first mark 'checking for side-effects' was given in the majority of responses but many candidates did not realise that vaccines were not given to people with the disease as they prevent not cure and not because they would become more ill.

Misconception

Vaccines are for prevention not curing disease.

Question 7 (b) (i)

(b) One new type of vaccine against influenza is made of mRNA. The vaccine contains mRNA taken from the influenza virus.

- When a person is vaccinated, influenza mRNA from the vaccine enters some of the person's cells.
- These cells use the mRNA to make influenza protein.

(i) Describe how the person's cells will use the influenza mRNA to make influenza protein.

.....

.....

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.....

.....

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

The higher performing candidates were given the ribosome mark, however full details explaining the full process of protein synthesis was less successfully answered.

Question 7 (b) (ii)

(ii) Explain how the person's body will react to the influenza protein **and** how this could protect them from catching influenza in the future.

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.....

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

A key misconception was highlighted in the responses to this question. Some candidates confused the terms antigens and antibodies and thought that antibodies became memory cells.

Misconception

A number of candidates thought that antibodies went on to make memory cells.

Exemplar 3

- The person's body will detect that the influenza protein is not meant to be there from its antigens
- White blood cell will produce antibodies to clump the influenza proteins together and engulf them.
- Some white blood cells will remain as memory cells, ready to release the antibodies specific to influenza if the person was to catch it in the future. [4]

END OF QUESTION PAPER

- This means that the person won't get ill from influenza next time as their body can fight it straight away

A good response that is given 3 marks. The candidate refers to the protein being recognised as an antigen, mark point 1 for white blood cells, mark point 4 for antibodies made and finally mark point 5 for memory cells made.

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