AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 4.4.1.2

Rate of photosynthesis

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**8**
Available paper years	**2018–2025**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

4.4.1.2 Rate of photosynthesis

Answer 01 · Mark scheme June 2018 | 8464/B/1H | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$		1	AO2 4.4.1.1
03.2	endothermic		1	AO1 4.4.1.1
03.3	measure the volume of gas released increase length of time	allow use a measuring cylinder / capillary tube / (gas) syringe allow sensible length of time allow video the investigation so you could re-count the bubbles later allow repeat the measurement at each distance several times **and** calculate a mean ignore references to using other distances	1 1	AO3 4.4.1.2
03.4	temperature affects **rate** of photosynthesis **or** temperature affects **rate** of bubble production (because) reaction / photosynthesis is controlled by **enzymes**	allow correct description of effect of temperature on rate allow high temperatures denature enzymes enzymes being denatured must be linked to high temperature	1 1	AO3 4.4.1.2

4.4.1.2 Rate of photosynthesis

Answer 01 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	evidence of squaring for **two** distances that double: 25 **and** 100 **or** 100 **and** 400		1	AO2 4.4.1.2
	calculate $1/d^2$ for **two** distances that double: 0.04 **and** 0.01 **or** 1/25 **and** 1/100 **or** 0.01 **and** 0.0025 **or** 1/100 **and** 1/400	allow **2** marks for these calculations without working ignore calculations for a third distance as long as two where the distance doubles are correct	1	AO2 4.4.1.2
	(therefore as distance doubles) light intensity is quartered		1	AO3 4.4.1.2
03.6	2 (bubbles would be produced)		1	AO3 4.4.1.2
	(as) very little light / energy for **photosynthesis** to occur	do **not** accept no light allow **2** marks for a quarter of the bubbles are produced as light distance doubles so 2 bubbles would be expected	1	AO2 4.4.1.2

4.4.1.2 Rate of photosynthesis

Answer 01 · Mark scheme

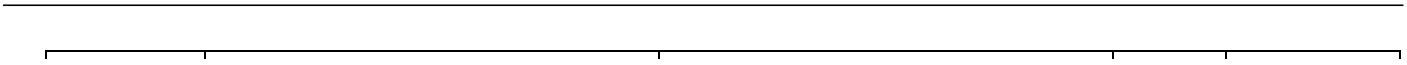
June 2018 | 8464/B/1H | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	(independent variable) use different concentrations of sodium hydrogencarbonate solution	allow three concentration values ignore different concentrations of carbon dioxide ignore different amounts of sodium hydrogen carbonate solution	1	AO3 4.4.1.2
	(control variables) any **two** from: • distance from light source • temperature of solution • same plant • time for plant to equilibrate	**max 2** marks for control variables allow light intensity ignore light unqualified ignore same lamp allow type / size of plant allow time for plant to adjust to different solution ignore time unqualified	2	
Total			**14**	

4.4.1.2 Rate of photosynthesis

Answer 01 · Mark scheme

June 2018 | 8464/B/1H | Original Q3



4.4.1.2 Rate of photosynthesis

Answer 02 · Mark scheme June 2018 | 8464/B/2H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	<table><tr><th>Factor</th><th>Biotic</th><th>Abiotic</th></tr><tr><td>Diseases</td><td>✓</td><td></td></tr><tr><td>Herbivores</td><td>✓</td><td></td></tr><tr><td>Temp</td><td></td><td>✓</td></tr><tr><td>Water</td><td></td><td>✓</td></tr></table>	allow **1** mark for 2 or 3 correct	2	AO1 4.7.1.3 4.7.1.2
01.2	(leaves block light near tree so) more light (as you move outwards) for photosynthesis (which) produces (more) glucose / proteins (for growth)	allow low light intensity under tree ignore Sun allow less photosynthesis under the tree ignore growth ignore food allow molecules, cell components or other correct substances instead of proteins if no other mark awarded allow less water / ions / minerals / nutrients under the tree	1 1 1	AO2 4.7.2.1 AO1 4.7.2.1 4.4.1.1 4.4.1.3 AO1 4.7.2.1 4.4.1.1 4.4.1.3
01.3	 quadrat light meter	in this order correct spelling only allow lux meter allow light intensity meter allow light data logger	 1 1	AO1 4.7.2.1
01.4	1.5(0) (m^2)	allow 15 000 cm^2	1	AO2 4.7.2.1

4.4.1.2 Rate of photosynthesis

Answer 02 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	to keep light (intensity) as similar as possible	allow the light (intensity) might change ignore references to temperature ignore weather ignore Sun	1	AO3 4.7.2.1
01.6	any **one** from: • repeat (investigation) around the tree • repeat (investigation) for other trees / areas • sample every one metre • count the number of each species present (rather than percentage cover)	allow repeat in different directions ignore repeats unqualified ignore repeat at different times / days / seasons ignore different size quadrat ignore random sampling	1	AO3 4.7.2.1
01.7	daisy		1	AO3 4.7.2.1
01.8	as light (intensity) increased so did the percentage / cover of plants up to 100% / maximum at 175 (arbitrary units)	ignore directly proportional ignore positive correlation unqualified ignore distance	1 1	AO3 4.7.2.1

4.4.1.2 Rate of photosynthesis

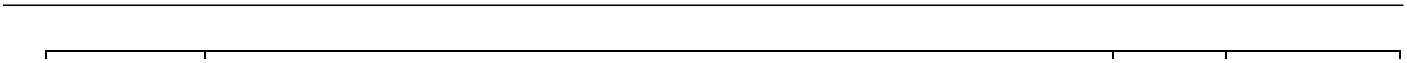
Answer 02 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.9	any pair from: • (lack of) water / rain (1) because the leaves are stopping the rain **or** because the roots of the tree are absorbing it (1) • (lack of) minerals / ions (1) because the tree (roots) have absorbed them (1) • temperature (1) because less thermal energy from the sun is reaching under the tree canopy (1)	ignore carbon dioxide do **not** accept oxygen allow soil moisture allow magnesium / nitrate / nutrients allow too cold / cooler allow 'heat' for thermal energy allow pH / acidity (1) because (some) fallen leaves are acidic (1)	2	AO2 4.7.2.1
Total			**15**	

4.4.1.2 Rate of photosynthesis

Answer 02 · Mark scheme

June 2018 | 8464/B/2H | Original Q1



4.4.1.2 Rate of photosynthesis

Answer 03 · Mark scheme

November 2020 | 8464/B/1H | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	measure the volume of oxygen produced in a given time **or** when more oxygen is produced in a given time the rate of photosynthesis is faster	a reference to rate is needed allow gas for oxygen allow when oxygen is produced faster the rate of photosynthesis is faster ignore the faster the rate of photosynthesis, the more oxygen is produced allow the slower the oxygen is produced the slower the rate of photosynthesis **or** less oxygen being produced in a given time, the slower the rate of photosynthesis	1	AO1 4.4.1.1 4.4.1.2 RPA 5
05.2	light (intensity)	ignore temperature	1	AO2 4.4.1.2
05.3	20 000 (lux)	allow answers in range 19 500 to 20 500 (lux)	1	AO3 4.4.1.2

4.4.1.2 Rate of photosynthesis

Answer 03 · Mark scheme

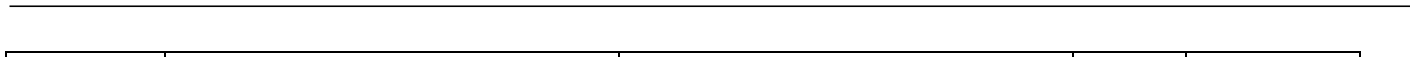
November 2020 | 8464/B/1H | Original Q5

05.4	there is a cost for heating the greenhouse		1	AO3 4.4.1.1 4.4.1.2
	there is a cost for increasing the carbon dioxide in the atmosphere (of the greenhouse)		1	
		allow there is a cost for lighting (in winter)		
	(therefore) the additional costs might exceed the (additional) sale price / profit **or** (additional) costs could not be recovered by increasing the sale price of the tomatoes	ignore these additional costs would reduce profits unqualified	1	
05.5	when there is no light there is no photosynthesis		1	AO1
	(so) no oxygen is produced		1	AO1
	(but) respiration happens (all the time) and oxygen is used		1	AO1
	(therefore) the net / overall oxygen production is negative / - 2 (arbitrary units)	do **not** accept an answer of -2 (arbitrary units) unqualified	1	AO2 4.4.1.1 4.4.1.2 4.4.2.1
Total			**10**	

4.4.1.2 Rate of photosynthesis

Answer 03 · Mark scheme

November 2020 | 8464/B/1H | Original Q5



4.4.1.2 Rate of photosynthesis

Answer 04 · Mark scheme November 2021 | 8464/B/1H | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	$6\,CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$		1	AO1 4.4.1.1
01.2	distance of the pondweed from the lamp		1	AO1 4.4.1.2 RPA5
01.3	bubbles (of gas) would be produced faster	allow more / bigger bubbles of gas would be produced (in a given time)	1	AO3 4.4.1.2 RPA5
	(because) enzymes work faster	allow (because) photosynthesis is controlled by enzymes allow (because) photosynthesis would be faster	1	AO2 4.2.2.1 4.4.1.2
01.4	any **one** from: • use an LED (lamp) • place a tank / beaker of water between the lamp and tube / pondweed • put the tube in a beaker of water • put the tube in a (thermostatically controlled) water bath • place a piece of glass between the lamp and tube / pondweed	allow use a light that does not emit (a lot of) infrared / thermal radiation allow place a heat shield between the lamp and tube / pondweed	1	AO3 4.4.1.2 RPA5

4.4.1.2 Rate of photosynthesis

Answer 04 · Mark scheme

November 2021 | 8464/B/1H | Original Q1

01.5	any **two** from: • measure the volume of gas produced • allow the pondweed time to equilibrate • repeat **and** calculate a mean **or** repeat **and** remove anomalies • control the concentration of carbon dioxide (in the water) • use the same bulb / lamp	 allow amount for volume allow use a cylinder / gas syringe to collect the gas allow a description of this ignore repeat unqualified allow put the pondweed in sodium hydrogen carbonate (solution) **or** sodium bicarbonate (solution) allow use the same type / size / age / piece of pondweed allow record the number of bubbles of gas produced in a longer period of time	2	AO3 4.4.1.2 RPA5
01.6	3 (bubbles of gas produced per minute)	allow 3.2 (bubbles of gas produced per minute) do **not** accept 3.0 (bubbles of gas produced per minute)	1	AO2 4.4.1.2 RPA5
01.7	as light intensity decreases the rate of photosynthesis decreases	allow as distance from lamp increases rate of photosynthesis decreases allow as distance from lamp increases number of bubbles produced decreases	1	AO3 4.4.1.2 RPA5

4.4.1.2 Rate of photosynthesis

Answer 04 · Mark scheme

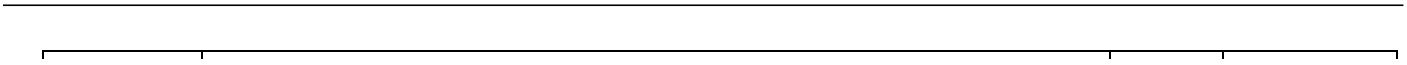
November 2021 | 8464/B/1H | Original Q1

01.8	all points plotted correctly line of best fit through their points	allow tolerance of ± ½ a small square allow **1** mark for four points plotted correctly do **not** accept line extended to 0, 0 ignore extrapolations of line	2 1	AO2 4.4.1.2 RPA5
01.9	8	allow correct value from their line ± ½ a small square allow value in range 6 to 9 if a curved line of best fit is not drawn	1	AO3 4.4.1.2 RPA5
Total			**13**	

4.4.1.2 Rate of photosynthesis

Answer 04 · Mark scheme

November 2021 | 8464/B/1H | Original Q1



4.4.1.2 Rate of photosynthesis

Answer 05 · Mark scheme

June 2022 | 8464/B/1H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	to transfer energy **or** photosynthesis is an endothermic reaction	allow idea that light is the source of energy (for the reaction) do **not** accept to produce / make / create / use energy	1	AO1 4.4.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$		1	AO1 4.4.1.1

4.4.1.2 Rate of photosynthesis

Answer 05 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	allow the pondweed to equilibrate in the light	allow leave the pondweed in the light (for a few minutes) before taking measurements allow use the same concentration of sodium hydrogen carbonate solution ignore control carbon dioxide concentration unless method described ignore use same intensity / distance of light ignore control temperature ignore use same pondweed	1	AO3
	use a gas syringe **or** use a (measuring) cylinder to measure / collect the oxygen / gas produced	do **not** accept carbon dioxide ignore references to counting bubbles	1	AO1
	measure time oxygen / gas is collected for using a timer / stopwatch / stopclock		1	AO1
	repeat the measurements **and** calculate a mean	allow repeat the measurements **and** discard anomalies	1	AO1 4.4.1.1 4.4.1.2 RPA5

4.4.1.2 Rate of photosynthesis

Answer 05 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4		ignore answers relating to the scale on the y-axis		AO2 4.4.1.2 RPA5
	independent variable in student's investigation is categoric / discrete	allow colour of light is a categoric / discrete variable ignore discontinuous	1	
	independent variable in scientist's investigation is continuous	allow wavelength is a continuous variable	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	492 to 577 (nm)	allow answers in ranges 475 to 525 **and** 575 to 650 (nm)	1	AO3 4.4.1.1 4.4.1.2 RPA5

Total Question 4		**9**

4.4.1.2 Rate of photosynthesis

Answer 06 · Mark scheme

June 2023 | 8464/B/1H | Original Q5

Question 5

Question	Answers	Mark	AO / Spec. Ref.
05	**Level 3:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO2
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	AO1
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	AO1
	No relevant content	0	

4.4.1.2 Rate of photosynthesis

Answer 06 · Mark scheme

June 2023 | 8464/B/1H | Original Q5

	Indicative content **Bright light:** • rate of photosynthesis is high due to high light intensity • (extra) carbon dioxide is absorbed from the air • (so) oxygen is released into the air • carbon dioxide produced in respiration is used for photosynthesis • (so) no carbon dioxide released from plant **or** into the air • sufficient oxygen for respiration is produced by photosynthesis • (so) no extra oxygen absorbed from the air • rate of photosynthesis is greater than rate of respiration **Dim light:** • no net / overall flow / exchange of carbon dioxide or oxygen with the air • (because) rate of respiration equals rate of photosynthesis • carbon dioxide produced in respiration is used for photosynthesis • no (extra) carbon dioxide is absorbed from the air • oxygen produced by photosynthesis is used in respiration • no (extra) oxygen is absorbed from the air **No light:** • no photosynthesis occurs as no light • (so) no carbon dioxide is absorbed and no oxygen released / produced • plant respires so takes in oxygen and releases carbon dioxide into the air **General points:** • plants photosynthesise when there is light using carbon dioxide and producing oxygen • rate of photosynthesis depends on light intensity • respiration occurs at all times of the day • respiration uses oxygen and produces carbon dioxide **Level 3** response must include explanation at all three light intensities, demonstrating a good understanding of both photosynthesis **and** respiration. For **Level 2** correct reference to **both** processes **and** to **both** gases		4.4.1.1 4.4.1.2 4.4.2.1

Total Question 5	**6**

4.4.1.2 Rate of photosynthesis

Answer 07 · Mark scheme

June 2024 | 8464/B/1H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$		1	AO2 4.4.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	(as temperature increases) the rate of photosynthesis increases **then** (the rate of photosynthesis) decreases	ignore references to volume unqualified	1	AO3 4.4.1.2
	fastest rate between 30 °C **and** 35 °C	allow a fastest rate at a temperature above 30 °C and below 35 °C allow reaches an optimum temperature between 30 °C and 35 °C	1	
	up to 30 °C the rate doubles every 5 °C increase	allow up to 30 °C the rate increases at an increasing rate allow up to 30 °C the rate increases exponentially	1	

4.4.1.2 Rate of photosynthesis

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	enzymes (in the plant / chloroplast) become destroyed	allow enzymes become denatured do **not** accept enzymes are killed do **not** accept cells / plants are denatured	1	AO2 AO3 4.2.2.1
	(because) <u>active site</u> changes shape **OR** the <u>active site</u> changes shape (1) (so) the substrate no longer fits / binds (1)		1	4.4.1.2
	OR enzymes (in the plant / chloroplast) become destroyed (1)	allow enzymes become denatured do **not** accept enzymes are killed do **not** accept cells / plants are denatured		
	(so) the substrate no longer fits / binds (1)	ignore the plant is killed / dead		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	repeat the investigation, measuring the volume of gas to 0.5 cm^3		1	AO3 4.4.1.2

4.4.1.2 Rate of photosynthesis

Answer 07 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	any **two** from: • may have too many tomatoes to eat / sell • other factors could limit photosynthesis • the optimum temperature might be above / below 25 °C • greenhouses are poorly insulated • pollution from the heater • increase the rate of transpiration • increased spread of plant disease(s)	allow the idea of a glut **or** all ripen at the same time allow other named limiting factor could limit photosynthesis allow factors could limit tomato production allow increase carbon dioxide emissions allow increase global warming allow increase the water loss from the plant if no other mark awarded allow it is a fire hazard for **1** mark	2	AO3 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	meristem		1	AO1 4.1.2.3

Total Question 4	**10**

4.4.1.2 Rate of photosynthesis

Answer 08 · Mark scheme

June 2025 | 8464/B/1H | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	10 cm^3 measuring cylinder with intervals of 0.1 ± 0.01 cm^3		1	AO1 4.4.1.2 RPA5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	*evidence of squaring for **two** distances that double:* (10 cm and 20 cm) 100 **and** 400 **or** (20 cm and 40 cm) 400 **and** 1600 **or** (30 cm and 60 cm) 900 **and** 3600	allow other appropriate values throughout	1	AO2 4.4.1.2 RPA5
	*calculate $1/d^2$ for **two** distances that double:* (10 cm and 20 cm) 0.01 / $\frac{1}{100}$ **and** 0.0025 / $\frac{1}{400}$ **or** (20 cm and 40 cm) 0.0025 / $\frac{1}{400}$ **and** 0.000625 / $\frac{1}{1600}$ **or** (30 cm and 60 cm) 0.001(11…) / $\frac{1}{900}$ **and** 0.00027(77…) / $\frac{1}{3600}$	allow **2** marks for these values without working	1	
	(therefore as distance doubles) light intensity is quartered		1	

4.4.1.2 Rate of photosynthesis

Answer 08 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	the rate of oxygen production increases	allow rate of photosynthesis increases ignore the volume of oxygen production increases unqualified	1	AO3
	(because) reactants / particles / molecules / enzymes have greater (kinetic) energy	allow reactants / particles / molecules / enzymes move faster	1	AO2
	(so) collisions are more frequent	allow (so) more collisions in a given time allow (so) more successful collisions	1	AO2 4.2.2.1 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	no / less oxygen (is produced)	allow photosynthesis is stopped / reduced allow the rate of oxygen production is 0 (cm^3/hour)	1	AO3
	(because) enzymes are destroyed	allow the enzymes are denatured allow active site has changed shape do **not** accept the cells / plant / pondweed is denatured do **not** accept the enzymes are killed	1	AO2 4.2.2.1 4.4.1.2

Total Question 3	9

4.4.1.2 Rate of photosynthesis

Answer 01 · Examiner comments

June 2018 | 8464/B/1H | Original Q3

Question 3 (standard, standard / high & high demand)

03.1 85% of students selected the correct balanced equation for photosynthesis. The most common incorrect equation selected was that which represented respiration.

03.2 This question tested a new part of the specification. 49% students identified photosynthesis as an endothermic reaction. 25% of students thought photosynthesis was an aerobic reaction, and fewer said it was an exothermic reaction.

4.4.1.2 Rate of photosynthesis

Answer 01 · Examiner comments June 2018 | 8464/B/1H | Original Q3

03.3 The question asked for two ways to measure the rate of photosynthesis more accurately. 8% of students achieved both marks, with 46% achieving one mark. This was usually for measuring the volume of gas released. Quite a lot of students suggested ways to do this, such as using a gas syringe, which was awarded a mark.

Relatively few students suggested increasing the length of time to collect the bubbles and some thought reducing the time would make the results more accurate.

Alternative ideas that gained credit included:

- using a video so the bubbles could be recounted afterwards
- repeating the measurements and calculating a mean (the whole of this statement was required for a mark).

Many students suggested carrying out the investigation using different distances, light intensities or sodium hydrogen carbonate concentrations, all of which were ignored.

03.4 The question asked why the pondweed had to remain at a constant temperature. 3% of students achieved both marks, and 54% were awarded one mark.

For the first marking point a reference to the effect of temperature on the rate of photosynthesis was required. Statements such as 'temperature affects photosynthesis' were ignored.

The second marking point was for stating that photosynthesis is controlled by enzymes, or that high temperatures denature enzymes.

03.5 62% of students achieved two marks for the correct calculation of $1 \div d^2$ for two distances that doubled. Calculations for all three distances were often given. Although the question said calculations **must** be included, quite a lot of students did not attempt any.

Students found the final mark, for explaining that as distance doubled the light intensity was quartered, the most difficult to express. For example, reduces by a quarter or decreases by four were incorrect. Many did not give a quantitative description, and said as distance increased light intensity decreased. This was insufficient.

03.6 50% of students were awarded the first marking point for predicting that two bubbles would be produced. This was the only answer allowed. Common incorrect responses were zero, one or four bubbles. 195 of students achieved both marks, as students found it difficult to give a reason for their prediction.

4.4.1.2 Rate of photosynthesis

Answer 01 · Examiner comments June 2018 | 8464/B/1H | Original Q3

03.7 Many students did not understand the term independent variable. Many of those who did, gave insufficient information to achieve the mark. They often said change the concentration of carbon dioxide, but did not describe how this could be done. Some suggested using different volumes of sodium hydrogen carbonate solution, but a reference to changing the concentration was needed.

The term control variable was better understood, but students did not always gain credit because their descriptions were too vague. For example, keep the light or lamp the same was insufficient. A reference to light intensity or the distance from the light source was needed. Temperature unqualified was ignored. It had to be clear that it was the temperature of the solution that should be controlled.

4.4.1.2 Rate of photosynthesis

Answer 02 · Examiner comments

June 2018 | 8464/B/2H | Original Q1

Question 1 (standard demand)

01.1 86% of students were able to identify two or three factors that were biotic or abiotic, with about 64% identifying all four correctly.

01.2 Most students noted that light increased as you moved away from the tree. However, a much lower number related light to photosynthesis and fewer still could link to glucose for growth, although some answered with 'providing food'. There were students who mixed up photosynthesis and respiration.

01.3 Many students identified a quadrat and most of these could spell it correctly. Much fewer identified the light meter, with solar panel and light dependent resistor (LDR) as the most common wrong answers. 'Lightometer' was seen but unless this was qualified as a mobile phone app it did not gain credit. Similarly a 'light sensor' was only correct if linked to a data logger.

01.4 Most students attempted a calculation, with 15% answering correctly. Some students were able to correctly calculate the area of one quadrat as 0.25 m^2 but then multiplied by either ten or five instead of the six sites sampled.

01.5 A wide variety of answers were seen suggesting that students understood that light intensity could change during the day. Provided the idea was clear credit was awarded.

01.6 The many students who just wrote 'repeat the investigation' did not gain credit. However 38% of students knew that this would only improve validity if it was in a different direction or for a different tree. Sampling every metre was also a correct common response.

01.7 74% of students identified 'daisy'. A number of students wrote more than one answer and so lost the mark under the list rule. Clover was a common incorrect answer, possibly because that was the species with the highest percentage cover at high light intensity rather than the species which **only** grew at high light intensity.

01.8 The first straightforward mark point for increasing light intensity showing an increased percentage cover of plants was stated by 62% of students although some incorrectly inferred that it was the percentage cover of plants causing the increased light intensity.

Only the most mathematically astute students were able to note that a maximum of 100% cover was seen from 175au of light for the second mark. A number of students did not read the question carefully enough and gave detailed descriptions of what was happening for each species instead.

4.4.1.2 Rate of photosynthesis

Answer 02 · Examiner comments June 2018 | 8464/B/2H | Original Q1

01.9 While 69% of students were able to identify a factor for one mark, often seen and credited within the reason section, very few were able to explain this in terms of the tree. Instead students gave very general reasons for why the factor was needed by plants. Many students wrote about the carbon dioxide level under a tree changing which is not the case.

Answer 04 · Examiner comments November 2021 | 8464/B/1H | Original Q1

Question 1 (standard demand)

This question assessed knowledge and understanding of Required Practical Activity 5: investigating the effect of light intensity on the rate of photosynthesis. Almost three-quarters of students correctly identified the balanced equation for photosynthesis. Just over half correctly identified the distance of the pondweed from the lamp as the independent variable.

More than two-thirds of students described how a higher temperature would increase the rate that the bubbles of oxygen were produced by the pondweed. A a quarter of students could explain why the rate would be faster at a higher temperature. A third of students suggested how the investigation could be improved so the temperature of the water did not increase, usually saying use an LED bulb. Many students did not understand what was being investigated and suggested moving the lamp further away from the pondweed. A third of students scored one of the marks for **01.5**, usually for saying that using the same pondweed would make the results more valid. Quite a lot of answers referred to carrying out repeats, but did not go on to say calculate a mean, or remove anomalies.

Half of the students correctly calculated the rate of photosynthesis as 3 bubbles of gas per minute. Common errors included dividing the distance by the number of bubbles produced at that distance, dividing a distance by 5 minutes, or dividing an incorrect number of bubbles by 5 minutes. **01.7** was answered well on the Higher Tier. Almost three-quarters of students made a correct conclusion describing the effect of light intensity on the rate of photosynthesis. Cause and effect had to be the correct way around, to link back to what the investigation was set up to find out.

4.4.1.2 Rate of photosynthesis

Answer 04 · Examiner comments November 2021 | 8464/B/1H | Original Q1

Most students correctly plotted the points on the graph, using a small cross drawn with a sharp pencil. Fewer than a third of students went on to join the points with a smooth curve. Most drew a ruled straight line. Fewer than half correctly extrapolated their line to predict the number of bubbles that would be produced if the lamp was 60 cm from the lamp.

Answer 05 · Examiner comments June 2022 | 8464/B/1H | Original Q4

Question 4 (standard, standard/high & high demand)

04.1 Half of the students scored the mark for saying light provides energy for photosynthesis, or that light is the source of energy for the reaction. A few correctly stated that photosynthesis is an endothermic reaction. Weak language, in relation to energy being produced or used, meant that some students were unable to demonstrate the knowledge to gain the mark.

04.2 88% of students selected the correct symbol equation for photosynthesis.

4.4.1.2 Rate of photosynthesis

Answer 05 · Examiner comments June 2022 | 8464/B/1H | Original Q4

04.3 This question was set at high demand. All points on the mark scheme were seen in student responses, but rarely more than two points were made in the same script. 41% of students scored one or more marks, most of which, achieved a single mark.

Most students did not pick up on the need to refer to making accurate measurements, but gave examples of variables to control. Many students said the measurements should be repeated, but they had to go on and say calculate a mean, or discard anomalies to gain credit. Several students referred to using a gas syringe or a measuring cylinder to measure the volume of gas produced. Few students said measure the time using a timer, or other suitable piece of equipment.

04.4 This question was set at high demand. 8% of students scored at least a mark for this question. Most students described what was being plotted in each graph. They did not say:

- colour of light is a categoric or discrete variable, and so plotted as a bar chart
- wavelength of light is a continuous variable, and so plotted as a line graph.

Quite a lot of students thought that the students plotted a bar chart because it is easier to draw and to understand than a line graph. Others said the scientists plotted a line graph because they had more data, or that their results were more accurate.

04.5 Students had to interpret two graphs to determine the range in wavelength of green light. Figure 8 showed that the rate of photosynthesis in green light was very low. Students had to use this information to interpret Figure 9. A range of values for the lower and upper ends of wavelength, when the rate of photosynthesis was low, were allowed. 39% of students achieved this mark.

Answer 06 · Examiner comments June 2023 | 8464/B/1H | Original Q5

Question 5

Levels 1 and 2 were set at high demand, and Level 3 was set at the highest level of demand.
Students who only described what the arrows on the diagrams showed, and did not attempt to explain the movement of gases into and out of the trees, did not score any marks. Almost half of the students gave a Level 1 response. These responses usually only referred to photosynthesis happening in bright light or not happening in the dark, and respiration was not mentioned.
A third of students gave a Level 2 response. In order to access Level 2 references to both photosynthesis and respiration, as well as to both gases, were needed. A lot of students only mentioned respiration happening in the dark.
In order to access Level 3 an explanation of the gas exchange in all three situations was needed. Realising that photosynthesis and respiration would be occurring at the same rate was key to explaining gas exchange in dim light. Those who said there would be no photosynthesis in dim light were limited to Level 2.

4.4.1.2 Rate of photosynthesis

Answer 07 · Examiner comments — June 2024 | 8464/B/1H | Original Q4

Question 4 (standard, standard/high & high demand)

04.1 Most students correctly selected the equation for photosynthesis.

04.2 This question proved very demanding, with 45% gaining 1 or more marks and 8% 2 or more. Students mostly commented on the volume of gas produced and not the rate of photosynthesis, which limited their ability to gain credit resulting in a maximum award of 1 mark. The most frequently awarded mark was for the optimum temperature between 30 °C and 35 °C. Many students only gave individual temperatures, eg 'the optimum temperature was at 30 °C', and therefore did not recognise that the fastest rate or optimum must have fallen between the two values given in the table. Comments about the rate doubling every 5 °C increase were rarely seen, so it was rare to see a 3-mark answer.

Many students attempted to explain why the rate changed due to enzymes, which did not answer the question and so did not gain any marks.

04.3 This question also proved challenging, with 38% gaining 1 or more marks. Responses that gained credit were usually for stating the enzyme was denatured and missing that the active site changed shape.

04.4 40% of students could select the correct way to improve the accuracy of the experiment.

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Answer 07 · Examiner comments — June 2024 | 8464/B/1H | Original Q4

04.5 This question was not answered well: 70% of students gained no credit, and students appear to have struggled to grasp the context. Many responses talked about enzymes being denatured, despite the temperature given as 25 °C. Students who gained 1 mark usually did so for stating the optimum temperature may be higher or lower, or that there may be another limiting factor.

Many students made generic comments about use of a heater being 'bad for the environment' or 'uses lots of energy'. These comments did not go far enough with a link to global warming or climate change and so did not gain credit.

04.6 Three-quarters of students picked meristem as cells that can differentiate in plant cells.

4.4.1.2 Rate of photosynthesis

GCSE

Combined Science: Trilogy

8464/B/1H Combined Science: Trilogy Biology Paper 1H

Report on the exam

Published: August 2025

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4.4.1.2 Rate of photosynthesis

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4.4.1.2 Rate of photosynthesis

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4.4.1.2 Rate of photosynthesis

Overview

This paper is one of the six examined components for Combined Science: Trilogy. All of these papers follow a similar structure and test the same assessment objectives.

This paper has 70 marks available to students and is made up of six questions.

- Approximately 40% of marks assess AO1; 40% of marks assess AO2; and 20% of marks assess AO3.
- Approximately 40% of marks target Standard demand, 40% of marks target Standard/High demand and 20% of marks target High demand.

Questions 1 and 2 on this paper and questions 5 and 6 on the Foundation Tier paper are common. These questions are identical and are targeted at Standard demand.

Questions are set at three levels of demand for this paper:

- **Standard demand** questions are designed to broadly target grades 4–5.
- **Standard/High demand** questions are designed to broadly target grades 6–7.
- **High demand** questions are designed to broadly target grades 8–9.

A student's final grade is based on their attainment across all six papers.

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4.4.1.2 Rate of photosynthesis

Summary of overall performance

Overall, students performed well on factual recall questions and straightforward mathematical calculations, whereas extended responses and the application of knowledge to unfamiliar contexts proved more challenging.

Strongest performance was observed in questions that tested basic recall or calculations. This was most noticeable in Questions **01.1**, **02.1** and **02.2**.
Students also performed well in the mathematical elements of the paper, particularly in **06.3** and **06.5**, where they demonstrated confidence in calculations involving standard form and percentages.

Moderate performance was seen in questions requiring straightforward application of knowledge, such as in **02.4**, and in **03.2**. Questions **05.2** and **06.1**, were also quite well answered by a significant proportion of students.

In contrast, a number of questions revealed significant difficulties for students, such as in **01.3**.
The extended response in **02.5** proved particularly challenging, as many students could describe the primary immune response but struggled to explain the secondary response in sufficient detail. Similarly, in **03.4** and **04.1**, students often gave imprecise answers which often lacked explanatory detail.

It is vital that students read all the information in each question and use it appropriately in their answers. Understanding the meaning of command words is particularly important. For example, ‘explain’ and ‘evaluate’ were often interpreted as ‘state’ or ‘describe’, leading to students missing out on marks. Question **06.6** was a notable example of this.

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4.4.1.2 Rate of photosynthesis

Question 1 (Standard demand)

01.1 This question was generally well answered. A significant proportion of students (48%) achieved both marking points, demonstrating strong understanding of the topic. Many responses showed accurate labelling and good recall of the key blood vessels associated with the heart.

Where only one mark was awarded, this was most commonly for the correct identification of the vena cava.

01.2 61% of students gained the mark for this question.

01.3 This question was generally well answered, with most students recognising the involvement of respiration. However, many did not explain that more energy was required, and the misconception that energy is 'produced' rather than 'released' in the mitochondria was common.

Only a small proportion demonstrated understanding that the heart muscle needs to contract, with few using this precise term. Confusion between the processes of respiration and breathing was common.

Overall, 35% of students achieved two or more marks, while only 7% gained full marks. Most gained partial credit for identifying respiration but struggled to explain how energy is used by the heart.

01.4 This question was well answered, with 71% of students gaining at least one mark. Tiredness and chest pain were the most frequently identified symptoms.

Some responses repeated the same idea using different wording, for example 'heart attack' and 'blood clot'. Terms such as 'heart murmur' or 'palpitations' were credited as irregular heartbeat, while 'heartburn' was not.
Descriptions of increased breathing rate were often too vague, and few students mentioned pale skin.

01.5 This question was generally well answered, with over 80% of students gaining at least one mark. Many correctly identified infection or rejection as valid risks, while fewer mentioned the risk from anaesthetic.

Weaker responses often rephrased the question, giving vague statements such as 'there is a risk from surgery', which were not creditworthy. Some students speculated about long-term outcomes, for example 'the heart tissue not growing' or 'the patch being too small'. These were outside the scope of the question and not accepted.

Answers referring to bleeding had to make clear that it resulted from the operation and involved a significant loss of blood, with terms such as 'heavy blood loss' being credited. General references to 'risk of disease' were also not sufficient.

Descriptions such as the heart being punctured or stopping were credited as examples of damage to the heart, but unqualified terms like 'harming the heart' or 'death' were not.

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Question 2 (Standard demand)

02.1 This question was very well answered, with 95% of students correctly identifying touch or direct contact as a method of transmission. Many also referred accurately to coughing, sneezing, or droplets, which were credited.

Vague examples like hugging or playing together were not creditworthy, as they did not clearly imply skin-to-skin contact. In contrast, examples such as kissing, high fives, or transmission via contaminated surfaces like shared towels were accepted.

02.2 This question was very accessible, with many students correctly stating that antibiotics are used to treat bacterial infections.

A common misconception was the claim that chickenpox is not a virus, revealing a misunderstanding of the nature of the disease. References to 'it' were interpreted as referring to chickenpox and were credited where appropriate.

02.3 Many students correctly referred to dead pathogens, which was creditworthy. However, vague answers such as 'dead cells', 'dead disease', or 'dead chickenpox' were not accepted, as students needed to identify that it was the pathogen, not the disease itself, used in the vaccine.

Unqualified statements such as 'a small amount' were insufficient unless clearly linked to the dead pathogen or the antigen. Terms such as 'inert' or 'dormant' were accepted as synonymous with inactive when applied correctly to the pathogen.

02.4 This question was generally well answered, with 87% of students gaining at least two marks. Many demonstrated a clear understanding of the concepts being assessed.

Errors most often arose from repeating the same idea using different wording, for example stating that the drug was tested 'to check for toxicity' and 'to check for side effects'. These were treated as equivalent and not credited twice. References to allergic reactions were also accepted as side effects, and statements such as 'to check it doesn't kill the person' were credited as showing awareness of the ultimate risk.

Terms such as 'efficient' and 'effective' were accepted as equivalent to efficacy. However, references to 'reliability' or 'accuracy' were not sufficient, as they do not directly address whether the drug works as intended. Overall, this was an accessible question, though more precise language would have improved some responses.

02.5 This extended response question was assessed holistically. Many students demonstrated a clear understanding of the primary immune response, often describing in detail how white blood cells produce specific antibodies. These responses typically met the criteria for Level 2, with 50% of students achieving this level.

Fewer students were able to describe the secondary immune response in sufficient detail to reach Level 3, with only 10% achieving this. Stronger answers successfully linked features such as the faster production of antibodies and the role of memory cells in enabling a quicker, more effective response. High-level responses also referred to the production of complementary antibodies and explained how this led to a rapid destruction of pathogens. Statements such as antibodies being 'produced sooner' were creditworthy, while vague phrases such as pathogens being 'fought off quickly' were not.

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4.4.1.2 Rate of photosynthesis

The function of white blood cells was generally well understood, and many students correctly described antibody production. However, credit for specificity required clarity that the antibodies produced were complementary or specific to the pathogen or its antigens. Simply stating that antibodies were produced was insufficient.

Confusion between antigens and antibodies was common and often affected the accuracy of responses. Overall, while the primary response was well described by most students, a lack of detail about the secondary immune response prevented many from progressing beyond Level 2. This question highlighted that the secondary immune response remains an area of weakness for many.

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4.4.1.2 Rate of photosynthesis

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0 2 . 5 Explain how a vaccine for chickenpox gives immunity against the disease.

You should refer to how the body responds to:

- the vaccine
- chickenpox pathogens that enter the body after vaccination.

[6 marks]

A Chickenpox Vaccine contains a dead or inert pathogen. This is then injected into the patients bloodstream. This causes the immune System to react to the new foreign pathogens. Lympho -cytes (White blood cells) ~~target~~ produce antibodies which are Specific to the antigens on the surface of the pathogen and then memory cells remember what antibodies to produce for the particular antigens of the bacteria. Thus, if you are actually injected you can produce antibodies quicker and kill the pathogens

Extra Space

This response was awarded 4 marks but had the potential to reach 6 with slightly more detail. The initial explanation of what a vaccine is was ignored, as this was assessed in a previous question.
The student correctly states that white blood cells produce antibodies, which satisfies the requirements for Level 2 and earns 3 marks. They further add that the antibodies are specific to the antigens—this additional piece of indicative content increases the mark within Level 2.

Credit is given for the mention of memory cells, and the student continues by stating that antibodies are produced more quickly upon infection. While this begins to reference the secondary response, it lacks a second linked idea, such as explaining that pathogens are destroyed more rapidly. Had this been included, the response could have progressed into Level 3, with up to 6 marks awarded.

This example reflects a common pattern seen on the Higher Tier, students providing accurate information but not developing it fully enough to access the Level 3 marks.

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Question 3 (High demand)

03.1 58% of students were awarded the mark for this question.

03.2 This question differentiated well between students of varying ability. Most were able to gain the first two marks by correctly selecting two distances from the graph that doubled and applying the inverse square law. A small number of students selected distances that did not double, such as 10 cm and 60 cm, which prevented them from achieving the calculation marks.

A few students used the incorrect formula 1/d rather than $1/d^2$, resulting in no credit. Others referred to the rate of oxygen production rather than calculating light intensity, which was also not credited. However, the majority used the correct formula and expressed their answers in an acceptable form.

Stronger answers correctly stated that light intensity 'decreases by a factor of four' or an equivalent phrase. Many, however, gave only vague statements such as 'light intensity decreases as distance increases', which were insufficient. A small number incorrectly stated that intensity 'reduced by 25%'.

03.3 This question was generally well answered, with 54% of students achieving at least one mark. Many correctly described that an increase in temperature leads to a higher rate of photosynthesis or faster oxygen production. Responses referring to the 'rate of bubble production' were credited, as the bubbles were identified as oxygen in the figure. However, answers that only mentioned an increase in oxygen volume or used vague terms such as 'rate of reaction' without linking this to photosynthesis were not sufficient.

Although many students described an 'increase of energy', It was often unclear what had more energy and vague statements about an energy increase for 'the plant' were not creditworthy. The idea of *more frequent* collisions was generally not well described. Responses that referred only to collisions, without further qualification did not gain credit.

Overall, most students gained at least one mark. However, only a minority demonstrated the particle-level understanding required to achieve full marks.

03.4 This question was challenging, with only 37% of students gaining at least one mark. References to other limiting factors, such as carbon dioxide, were not credited.

Many students correctly stated that high temperatures lead to less oxygen production, but only those who linked this to enzyme denaturation gained full marks. Responses that referred vaguely to cells or pondweed being denatured were not accepted.

Incorrect answers often suggested that oxygen production would increase or remain unchanged. Some students gave irrelevant points about experiment accuracy, which were not creditworthy.

Overall, while many achieved partial marks, few used precise biological terminology or explained the cause-and-effect relationship needed for full credit.

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Question 4 (Standard and High demand)

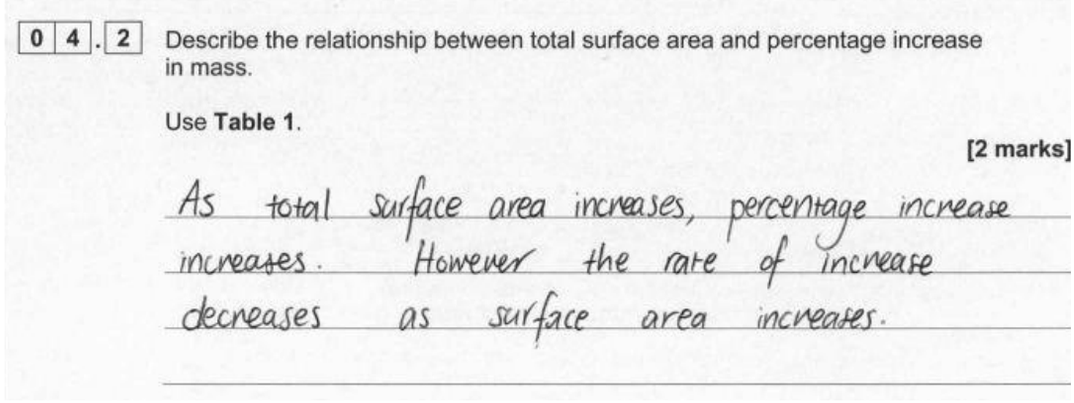
04.1 To gain credit, students needed to state that the potato pieces had different *starting* masses, making answers such as 'they have different mass', insufficient.

References to precision, accuracy, or comparability were not credited unless clearly linked to the variation in starting mass. Few students fully explained why using percentage change is more valid, with many giving vague responses such as 'more accurate' or 'more reliable'.

Some incorrectly attributed the use of percentage change to differences in surface area, which was not relevant. Others noted that it made results 'easier to compare', but did not go on to explain why.

04.2 This question was well answered, with 86% of students correctly identifying a positive correlation, stating that as surface area increases, the percentage increase in mass also increases.

A common error was the incorrect use of the term 'directly proportional', which was not credited as the relationship was not linear. Only 3% of students demonstrated higher-level understanding by noting that the rate of increase slowed, showing awareness of the diminishing trend in the data.


0 4 . 2 Describe the relationship between total surface area and percentage increase in mass.

Use **Table 1**.

[2 marks]

As total surface area increases, percentage increase increases. However the rate of increase decreases as surface area increases.

This is a rare response that was awarded 2 marks. The student successfully describes a decreasing rate, which meets the criteria for marking point 2. This level of detail and understanding was not commonly seen, as many students did not refer to the full pattern shown in the table.

04.3 To gain credit, students needed to state both the direction of water movement and name the process as osmosis. While most correctly identified osmosis, many omitted the direction of movement.

Explanations were credited if they described water moving from a high to low concentration of water, although this less precise wording often caused confusion. The preferred description was water moving from a dilute solution to a more concentrated solution across a partially permeable membrane. Statements referring to movement from low to high solute concentration were also accepted.

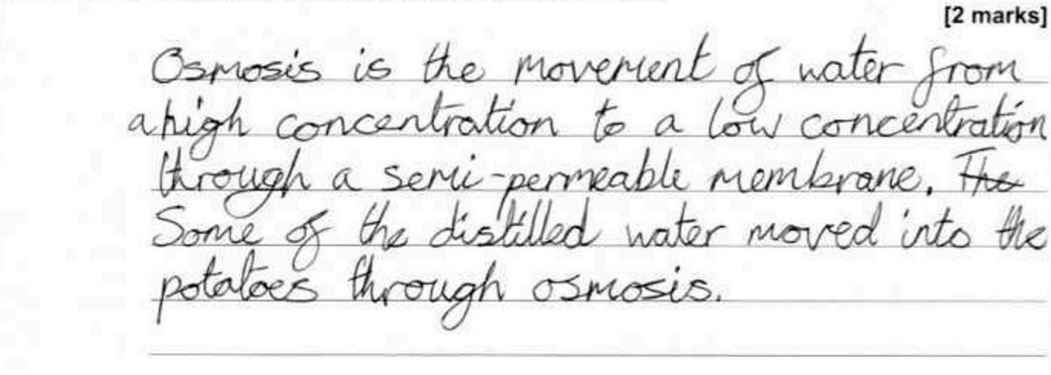
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4.4.1.2 Rate of photosynthesis

Confusion about concentration remained common, with many students not distinguishing between water and solute concentration. Although most could name osmosis, unclear explanations of the gradient and movement direction often prevented full marks.

0 4 . 3 Explain why the potato pieces increased in mass.

[2 marks]


Osmosis is the movement of water from a high concentration to a low concentration through a semi-permeable membrane. ~~The~~ Some of the distilled water moved into the potatoes through osmosis.

This response was awarded 1 mark for a correct description of the movement of water into the potato by osmosis.
However, a common misconception is evident in the explanation that 'water moves from a high concentration to a low concentration.' While this is frequently seen, it lacks precision. The addition of 'water' before both references to concentration would have been acceptable, though not ideal.
This error highlights a widespread misunderstanding of the principles of osmosis, particularly in relation to concentration terminology.

04.4 This question was particularly challenging, with only 4% of students gaining any marks. It required application of knowledge about osmosis in a broader context.

Few students recognised that all potato pieces would eventually reach the same percentage change in mass after 24 hours. Many incorrectly stated that the pieces would have the same mass, showing misunderstanding of what percentage change represents.

Credit was also given for identifying that it is the potato *cells*, not the whole pieces or the potato, that becomes turgid.

Common misconceptions included the belief that concentrations would equalise, and osmosis would stop, that percentage change would increase indefinitely, or that cells would burst. The role of the cell wall in preventing bursting was rarely acknowledged.

Overall, this question highlighted significant gaps in students' understanding of osmosis, particularly in distinguishing between plant tissues and plant cells.

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4.4.1.2 Rate of photosynthesis

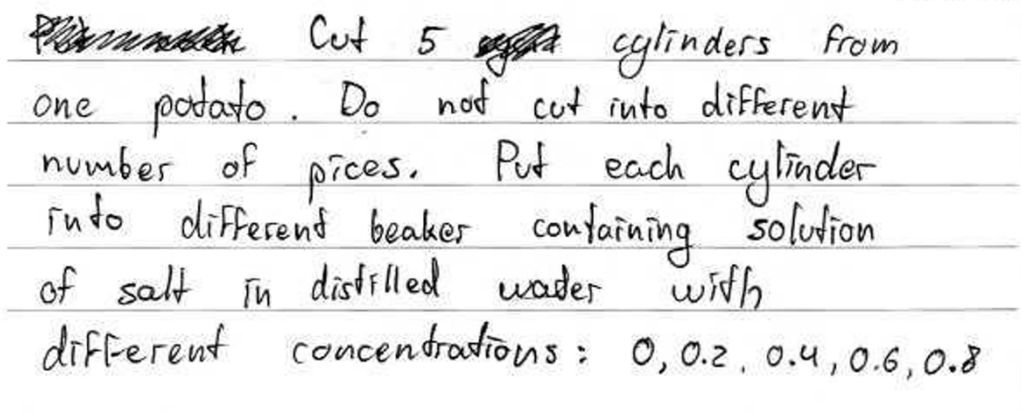
04.5 This question was poorly answered, with only 8% of students meeting both criteria. Many responses lacked precision and failed to clearly describe how the method should be adapted. Few students stated that the independent variable should be different concentrations of salt solution. References to at least three concentrations and the use of units such as g/dm^3 clarified that solutions, not masses of salt, were being tested. Vague statements such as 'add some salt to water' were not credited. Many students also failed to recognise that surface area needed to be replaced as the independent variable, often attempting to include both variables in the same method.

For controlling surface area, responses needed to state that all potato pieces should have the same surface area and not just the 'same size' or 'same shape' which were too vague. Students could also gain credit by stating that the cylinders should not be cut further or should be cut into the same number of pieces, as this implied control of surface area. Very few students addressed this point at all.

Overall, most responses demonstrated confusion around the concept of concentration and lacked the clarity required to access the marks.

Describe how the student could change the method to investigate the effect of salt concentration on potato tissue.

[2 marks]



This is a rare example of a 2-mark response. The student correctly refers to not cutting the pieces of potato, which demonstrates an understanding of the need to control the size and surface area of the samples. They also clearly state that different concentrations of salt solution were used, which shows an awareness of how to create the range of conditions needed to observe a pattern in mass change.

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4.4.1.2 Rate of photosynthesis

Question 5 (Standard and High demand)

05.1 49% of students gained 1 mark on this question. 34% gained full marks for this question.

05.2 This question proved challenging, with 63% of students failing to achieve the mark. While many correctly identified the palisade layer, a wide range of incorrect responses was seen.

Common errors included confusing the palisade tissue with the upper epidermis, spongy mesophyll, or simply writing 'mesophyll', which was too vague to credit. Other incorrect answers suggested other plant tissues and sub-cellular structures.

Overall, the question highlighted that while some students had a good grasp of leaf anatomy, many lacked precise knowledge of the location and function of palisade tissue.

05.3 This question was challenging, with 62% of students failing to achieve any marks. It required understanding of the adaptations of palisade mesophyll tissue and how these relate to its role in photosynthesis. While some students identified one appropriate adaptation or function, few provided the full explanation needed for both marks.

Many students correctly stated that the cells contain many chloroplasts or a large amount of chlorophyll. However, common errors included mentioning a 'large surface area', omitting the quantifier 'many', or failing to link the adaptation to its function. Responses such as 'contains chloroplasts for photosynthesis' were too vague, whereas answers specifying that the many chloroplasts absorb light for photosynthesis were awarded full credit.

Some students incorrectly described the position of the palisade cells at the top of the leaf or referred to unrelated processes such as water absorption or gas exchange. Confusion between palisade and spongy mesophyll tissues was also frequent.

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4.4.1.2 Rate of photosynthesis

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0 5 . 3 Explain how tissue **A** is adapted to its function.

[2 marks]

has many chloroplasts and so many chlorophyll so photosynthesis can take place ~~at a higher~~

0 5 . 3 Explain how tissue **A** is adapted to its function.

[2 marks]

contains lots of chloroplast wich contains chlorophyll to absorb the light thats why its on the top side of the leaf as thats where there is the highest light intensity

Two examples of responses that were both limited to 1 mark.

In the first example, the student is awarded for correctly stating that the cell contains many chloroplasts. However, further credit is not gained, as the response only references photosynthesis and does not specifically mention the absorption of light—an essential part of that marking point.

In the second example, the student is again awarded marking point 1 for correctly identifying the presence of many chloroplasts. This time, the student does mention light absorption but does not go on to link this to the process of photosynthesis.

In both cases, the students demonstrated partial understanding but did not provide enough detail to access full marks. This pattern was common across responses, where students often gave either the function (photosynthesis) or the mechanism (light absorption), but not both.

05.4 This question was challenging, with many students demonstrating only partial understanding. While 77% gained at least one mark, only 26% achieved three or more. Few were able to provide a full, coherent sequence of the pathway of water.

Most students gained credit for stating that water enters the root hair cells from the soil. However, answers that referred only to ‘roots’ or incorrectly described the process as active transport were not credited.

Fewer students successfully described water moving up the xylem, as many omitted the direction of flow or confused the xylem with the phloem, sometimes incorrectly referring to translocation instead of transpiration.

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References to water moving to the leaves were rare, with many responses diverting into discussions of photosynthesis, which was not relevant to the mark scheme.

Only a small number of students mentioned stomata or described their role in water leaving the leaf. Evaporation or transpiration as the final stage of water loss was more commonly stated, although it had to be correctly located to gain credit.

Overall, while the early and final stages of the process were better understood, students often lacked the precision and sequencing needed for full marks. This question highlighted persistent misconceptions about water transport and the role of specific plant structures.

Question 6 (High demand)

06.1 61% of students gained the mark for this question.

06.2 This question required students to apply their knowledge of ciliated cells in a new context. To gain credit, answers needed to describe the movement caused by the cilia (e.g. push, sweep, waft, pass through) and correctly identify what was being moved (e.g. egg, ovum, fertilised egg, or embryo). Phrases such as 'pass the egg through' were accepted, and incorrect references to the egg's destination were ignored. References to sperm were not credited.

Many students struggled, often confusing the roles of cilia and mucus. A common error was stating that cilia trap bacteria or pathogens, a function associated with mucus in the respiratory system rather than the oviduct.

06.3 Students generally performed well on this question, with 47% achieving full marks. Most were able to recall and correctly rearrange the equation, demonstrating strong mathematical skills.

The most common error was incorrect conversion from millimetres to micrometres, which prevented many from gaining the conversion mark. Some students also substituted values incorrectly, leading to an incorrect final answer.

Overall, performance was good, and many students showed confidence with both standard form and the calculation process. Clear working remains important, as it allows credit to be given for correct steps even when the final answer is incorrect. Students should also cross out incorrect attempts to make their reasoning clear.

06.4 This question proved difficult for many students, as it required clear application of knowledge about oxygen transport and respiration.

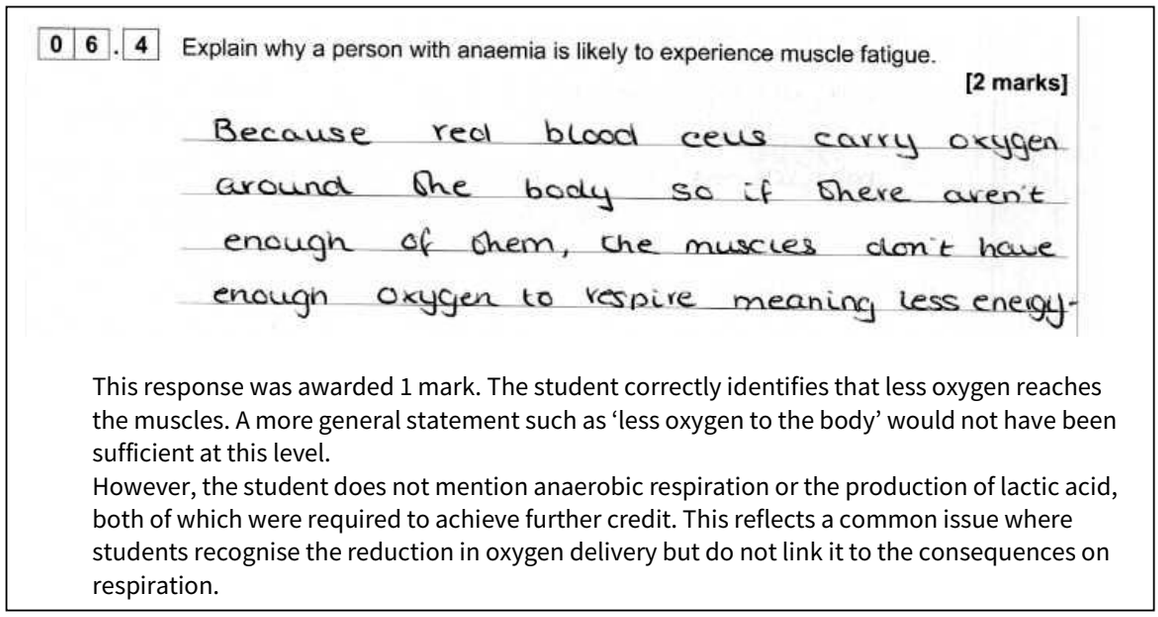
Many recognised that anaemia reduces oxygen transport but often used vague phrasing such as 'less oxygen is taken to the body', which was not credited. To gain the mark, answers needed to specify that oxygen was not reaching cells, muscles, or another specific destination. Irrelevant organs, such as the liver, and absolute statements like '*no* oxygen is taken to the cells' were not accepted.

Fewer students successfully identified the shift to anaerobic respiration and the associated production of lactic acid. Responses that referred only to 'less energy' or 'less aerobic respiration' were insufficient, and mentioning anaerobic respiration without lactic acid was also insufficient.

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4.4.1.2 Rate of photosynthesis

Overall, while many students understood the initial effect of reduced oxygen transport, few linked this to the physiological consequences of anaerobic respiration, revealing gaps in applying respiration knowledge in unfamiliar contexts.



0 6 . 4 Explain why a person with anaemia is likely to experience muscle fatigue.

[2 marks]

Because red blood cells carry oxygen around the body so if there aren't enough of them, the muscles don't have enough oxygen to respire meaning less energy.

This response was awarded 1 mark. The student correctly identifies that less oxygen reaches the muscles. A more general statement such as 'less oxygen to the body' would not have been sufficient at this level.
However, the student does not mention anaerobic respiration or the production of lactic acid, both of which were required to achieve further credit. This reflects a common issue where students recognise the reduction in oxygen delivery but do not link it to the consequences on respiration.

06.5 This question was generally well answered, with 67% of students gaining full marks. Many demonstrated strong mathematical skills and successfully applied standard form.

The most common errors were in the percentage calculation, which led to incorrect final answers despite correct method or structure. Magnitude errors, often caused by misplacing zeros, were also frequent.
Students who made calculation errors but correctly expressed their answer in standard form were often able to gain partial credit.

06.6 Most students (83%) accessed Level 1 by identifying relevant points, 47% reached Level 2, but only 1% achieved Level 3. The question highlighted weaknesses in data interpretation, comparative reasoning, and structuring evaluations.

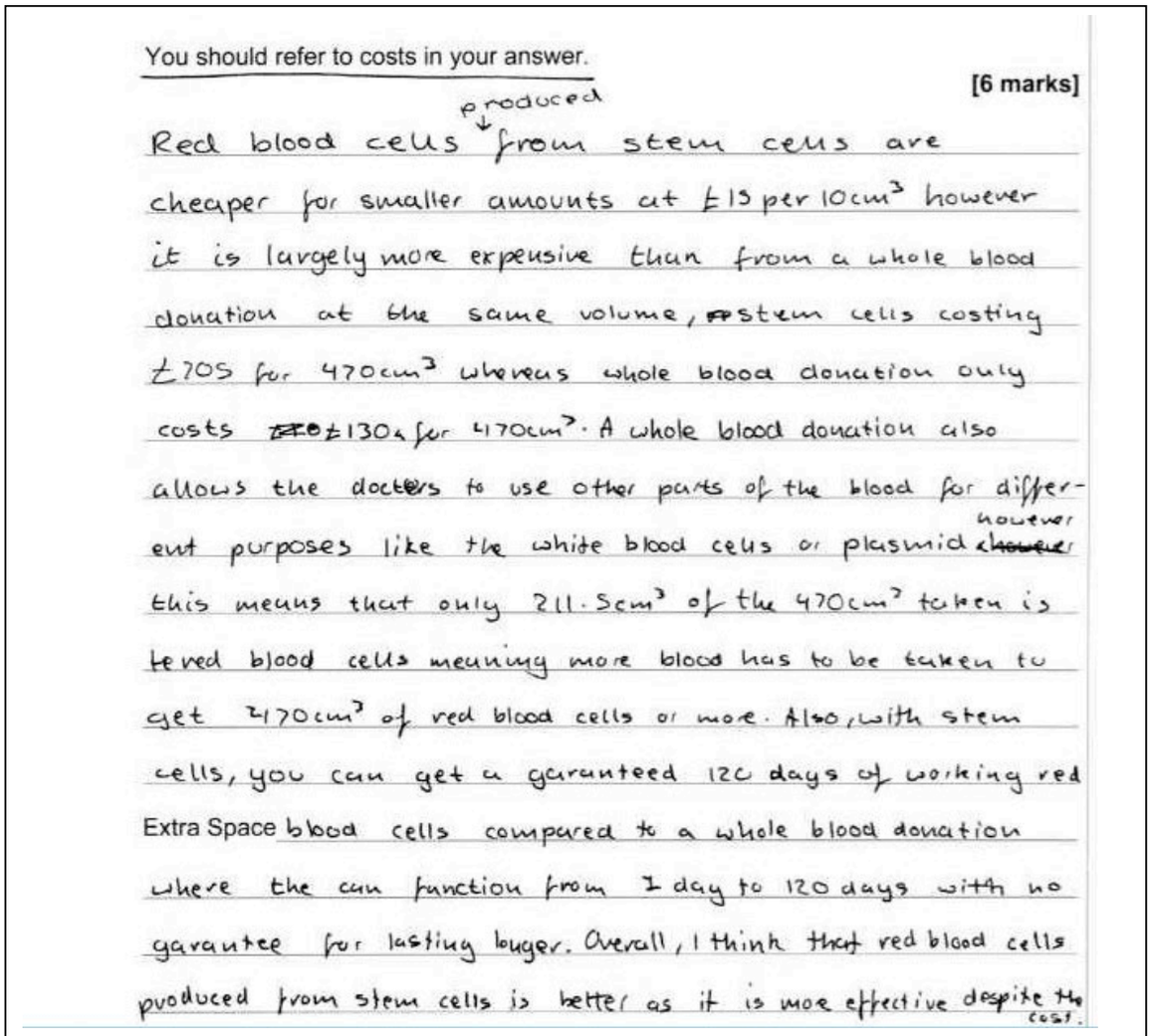
Many students correctly identified advantages of stem cell-derived red blood cells, including longer shelf life, smaller sample requirements, and lower risk of infection. Some gained credit by framing these as disadvantages of whole blood donation. However, many answers simply re-stated information from the table without comparison or explanation.

Disadvantages of stem cells were rarely mentioned. While cost was often noted, few students developed this point or compared it effectively with the lower cost of whole blood donation. Misconceptions were common, particularly references to ethical concerns about embryonic stem cells, which were not relevant in this context. Few students recognised benefits such as reduced risk of rejection or potential advantages for patients with rare blood types.

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4.4.1.2 Rate of photosynthesis

Source appendix · Full source examiner report



You should refer to costs in your answer.

[6 marks]

Red blood cells produced from stem cells are cheaper for smaller amounts at £15 per 10cm³ however it is largely more expensive than from a whole blood donation at the same volume, ~~F~~stem cells costing £705 for 470cm³ whereas whole blood donation only costs ~~£~~£130 for 470cm³. A whole blood donation also allows the doctors to use other parts of the blood for different purposes like the white blood cells or plasmid ~~however~~ however this means that only 211.5cm³ of the 470cm³ taken is red blood cells meaning more blood has to be taken to get 470cm³ of red blood cells or more. Also, with stem cells, you can get a garanteed 120 days of working red blood cells compared to a whole blood donation where the can function from 1 day to 120 days with no garantee for lasting longer. Overall, I think that red blood cells produced from stem cells is better as it is more effective despite the cost.

Extra Space

This is a rare example of a response that was awarded 5 marks.

The student correctly states that red blood cells produced from stem cells are more expensive and identifies the specific cost as £705, meeting two of the cost-related points.

They then note that whole blood donation includes other components, such as white blood cells, and despite the incorrect reference to plasma, this is accepted as being in line with the indicative content principles. The student also explains that these additional components can be used for different purposes. This was sufficient to award credit relating to the advantages of whole blood donation.

The response continues with an extended discussion about the lifespan of different types of blood cells. Although somewhat lengthy, the student eventually makes the point that red blood cells derived from stem cells last longer—earning credit for an advantage of stem cell blood.

In total, this response gained credit for cost-related points, advantages of whole blood donation, and an advantage of stem cell blood. Had the student included a further distinct advantage of stem cell blood, they would have been awarded the full 6 marks.

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4.4.1.2 Rate of photosynthesis

Cost evaluation was key to higher marks. Many students performed calculations correctly, allowing progression beyond Level 1, but errors occurred when comparing unequal volumes. Correct intermediary calculations were still credited.

Overall, while most students identified some valid points, only a very small proportion produced well-developed evaluations supported by data analysis.

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4.4.1.2 Rate of photosynthesis

Contact us

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