AQA GCSE Biology | 8461

SPECIFICATION POINT 4.4.1.2

Rate of photosynthesis

Mark schemes and examiner comments

Tier	**Higher**
Question groups	**20**
Available paper years	**2008–2025**

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 2008 | BLY2H | Original Q6 | Legacy

question	answers	extra information	mark
6(a)	any **three** from: • ((mean) mass) increases up to 7 / 8 units (of light) then levels off • light limiting factor up to 7 / 8 units • for photosynthesis • other factor / temperature limiting above 7 / 8 units	must be in correct context	3
6(b)	any **two** from: • cost of providing conditions / heat / light / CO_2 • effect of treatment on profit • relevant use of data from graph eg limiting factors • named other factors eg fertiliser / pest control / weeds / density of planting	allow too much of factor is wasteful allow taste / appearance	2
6(c)	**nitrate function** produce amino acids / proteins / enzymes **nitrate deficiency** stunted growth **magnesium function** produce chlorophyll **magnesium deficiency** yellow leaves / plant	ignore DNA do **not** allow chlorophyll allow description ignore plant dies ignore chloroplasts ignore plant dies	1 1 1 1
Total			**9**

4.4.1.2 Rate of photosynthesis

Answer 02 · Mark scheme June 2009 | BLY2H | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)(i)		answers must be in this order	
	water / H_2O	allow hydrogen oxide	1
	oxygen / O_2 / O	allow upper and lower case symbols and superscripts	1
1(a)(ii)	respiration in the plant	allow clear indication of correct response	1
1(b)	light (: no light) / light intensity	ignore references to the card / covered / uncovered	1
	chlorophyll (: no chlorophyll) / chloroplast	allow leaf colour **or** both green **and** white given	1
1(c)(i)	no light (received) **or** it's dark	allow no photosynthesis do **not** allow little light / photosynthesis ignore sun apply list principle for other factors	1
1(c)(ii)	no chlorophyll / chloroplasts (present)	allow no / little photosynthesis allow white **or** not green **or** little chlorophyll / few chloroplasts apply list principle for other factors	1
Total			**7**

4.4.1.2 Rate of photosynthesis

Answer 02 · Mark scheme

June 2009 | BLY2H | Original Q1 | Legacy

BLY2H

4.4.1.2 Rate of photosynthesis

Answer 03 · Mark scheme

January 2010 | BLY2H | Original Q4 | Legacy

Question 4

question	answers	extra information	mark
4(a)(i)	oxygen produced		1
4(a)(ii)	any **one** from: • average / mean / median • some may be anomalous	ignore reliable / precise / accurate allow some may not float	1
4(b)(i)	any **two** from: • low intensity / below 12.5 / 2.5 – 12.5 *(*units of light*)* flat wrack / it, rate of photosynthesis faster **or** saw wrack rate of photosynthesis slower • high intensity / above 12.5 / 12.5 – 15 (units of light) flat wrack / it, rate of photosynthesis slower **or** saw wrack rate of photosynthesis faster • same (rate) at 12.5 units	do **not** allow answers in terms of time only if candidate answers in terms of comparing rate of change then the rate of change of photosynthesis must be in the correct direction for **1** mark allow any value in range allow any value in range	2

Question 4 continues on the next page

4.4.1.2 Rate of photosynthesis

BLY2H

Question 4 continued

question	answers	extra information	mark
4(b)(ii)	any **two** from: • saw wrack receives less light • less photosynthesis **or** less carbohydrate / sugar / starch production • when tide is in **or** at high tide **or** any tide above low tide	accept converse if clear reference to bladder wrack if first and second responses, 'less' needed only once accept saw wrack covered by water / submerged longer / more reference to position on shore is insufficient	2
Total			**6**

4.4.1.2 Rate of photosynthesis

Answer 03 · Mark scheme

January 2010 | BLY2H | Original Q4 | Legacy

BLY2H

4.4.1.2 Rate of photosynthesis

Answer 04 · Mark scheme June 2010 | BLY2H | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)	the starch is stored for later use.		1
1(b)(i)	any **two** from: • carbon dioxide (concentration) • light intensity • light colour / wavelength • pH • size / amount plant • same / species / type plant • amount of water in the tube	do **not** accept temperature – apply list principle ignore reference to time allow **one** mark for light if neither intensity or colour are awarded allow 'the plant' ignore amount of water alone	2
1(b)(ii)	number / amount of bubbles **or** amount of gas / oxygen (relevant reference to) time / named time interval	allow volume of bubbles (together) ignore 'the bubbles' unqualified allow how long it bubbles for do **not** accept time bubbles start / stop ignore speed / rate bubbles ignore instruments do **not** accept other factors eg temperature accept how many bubbles per minute for **2** marks	1 1
1(c)(i)	temperature	allow heat / °C / cold	1
1(c)(ii)	carbon dioxide / CO_2	allow CO2 / CO^2 / Co_2 / Co^2 / co_2 / co^2 do **not** accept CO / 2CO	1
Total			**7**

4.4.1.2 Rate of photosynthesis

Answer 04 · Mark scheme

June 2010 | BLY2H | Original Q1 | Legacy

BLY 2H

4.4.1.2 Rate of photosynthesis

Answer 05 · Mark scheme January 2011 | BLY2H | Original Q1 | Legacy

Question 1

question	answers	extra information	mark
1(a)(i)	colour of light / bulb / lamp	allow wavelength for colour allow bulb alone do **not** accept light / colour unqualified	1
1(a)(ii)	any **one** from eg • temperature • light intensity **or** distance between lamp and plant / tube • carbon dioxide • other light in room • mass / size / amount / age / type of pondweed • volume / amount of water	 allow heat allow amount / brightness of light ignore light unqualified allow symbols allow use a dark room allow same piece of pondweed ignore pondweed unqualified ignore reference to time	1
1(a)(iii)	improved reliability **or** can spot anomalies / changes	allow for reliability **or** less likely to lose count allow reference to calculating a mean / average ignore reference to accuracy / precision / fair	1
1(b)(i)	green		1

Question 1 continues on the next page

4.4.1.2 Rate of photosynthesis

BLY2H

Question 1 continued

question	answers	extra information	mark
1(b)(ii)	any **two** from: • least / less bubbles / gas / oxygen / mean • least / less photosynthesis • least / less glucose / sugar / carbohydrate / food made	ignore references to colour reference to least / less needed only once, in context, for **2** marks only penalise no once, ie no bubbles = **0** mark no bubbles so no photosynthesis = **1** mark allow most / more green light reflected (by chloroplasts)	2
Total			**6**

4.4.1.2 Rate of photosynthesis

Answer 05 · Mark scheme

January 2011 | BLY2H | Original Q1 | Legacy

BLY2H

4.4.1.2 Rate of photosynthesis

Answer 06 · Mark scheme June 2011 | BLY2H | Original Q5 | Legacy

Question 5

question	answers	extra information	mark
5(a)(i)	increase (and then level off) **and** max / up to at 0.15(%) (carbon dioxide)	ignore references to oxygen concentration only ignore mention of 23	1
5(a)(ii)	$\underline{CO_2}$ is limiting at low CO_2 / at first light is limiting at high CO_2 / at end	ignore specific numbers	1 1
5(b)	 effect: (oxygen) falls explanation: (oxygen) used for respiration	**mark both parts together** **if no other marks** awarded allow (effect) no change **and** (explanation) no photosynthesis for **1** mark	 1 1
5(c)	more chlorophyll / chloroplasts allows more photosynthesis / description	 for both marks must refer to more at least once	1 1
Total			**7**

4.4.1.2 Rate of photosynthesis

Answer 06 · Mark scheme

June 2011 | BLY2H | Original Q5 | Legacy

BLY2H

4.4.1.2 Rate of photosynthesis

Answer 07 · Mark scheme

June 2012 | BL2HP | Original Q3 | Legacy

Question 3

question	answers	extra information	mark
3(a)(i)	(white) clover		1
3(a)(ii)	reed sweet-grass	allow reed allow grass	1
3(a)(iii)	(only) found in swamp and aquatic zones **or** only found in water **or** doesn't grow in marsh	ignore wet conditions	1

3(b) — 6

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 2, and apply a 'best-fit' approach to the marking.

0 marks	Level 1 (1-2 marks)	Level 2 (3-4 marks)	Level 3 (5-6 marks)
No relevant content.	There is a basic description which describes how a quadrat **or** a metre tape could be used to collect data	There is a clear description of how a quadrat **and** a metre tape could be used to collect data along a line	There is a clear, logical and detailed description of a method that will produce valid, repeatable results across / at intervals along the stream.

examples of procedural points made in the response:

- use of tape measure to produce transect
- placing of quadrats
- transect placed across stream
- score presence of each plant species
- use quadrat at regular intervals along tape
- repeat transect several times (≥ 3)
- along stream
- at random **or** regular intervals

Total			9

4.4.1.2 Rate of photosynthesis

Answer 07 · Mark scheme

June 2012 | BL2HP | Original Q3 | Legacy

BL2HP

4.4.1.2 Rate of photosynthesis

Answer 08 · Mark scheme

June 2012 | BL2HP | Original Q5 | Legacy

Question 5

question	answers	extra information	mark
5(a)	LHS: carbon dioxide **AND** water	in either order accept CO_2 **and** H_2O allow CO2 and H2O if names given ignore symbols do **not** accept CO^2 / H^2O / Co / CO ignore balancing	1
	RHS: sugar(s) / glucose / starch / carbohydrate(s)	accept $C_6H_{12}O_6$ allow C6H12O6 do **not** accept $C^6H^{12}O^6$	1
5(b)(i)	light is needed for photosynthesis **or** no photosynthesis occurred (so no oxygen produced)		1
5(b)(ii)	oxygen is needed / used for (aerobic) respiration	full statement respiration occurs **or** oxygen is needed for anaerobic respiration gains **1** mark	2
5(c)(i)	(with increasing temperature) rise then fall in rate use of figures, ie max. production at 40 °C **or** maximum rate of 37.5 to 38		1 1

Question 5 continues on the next page . . .

4.4.1.2 Rate of photosynthesis

BL2HP

Question 5 continued

question	answers	extra information	mark
5(c)(ii)	25 – 35 °C **either** faster movement of particles / molecules / more collisions **or** particles have more energy / enzymes have more energy **or** temperature is a limiting factor over this range 40 – 50 °C denaturation of proteins / enzymes	 ignore denaturation of cells ignore stomata	 1 1
5(d)	above 35 °C (to 40 °C) – little increase in rate **or** >40 °C – causes decrease in rate so waste of money **or** less profit / expensive because respiration rate is higher at >35 °C **or** respiration reduces the effect of photosynthesis		1 1 1
Total			**12**

4.4.1.2 Rate of photosynthesis

Answer 08 · Mark scheme

June 2012 | BL2HP | Original Q5 | Legacy

BL2HP

4.4.1.2 Rate of photosynthesis

Answer 09 · Mark scheme

Question 1

question	Answers	extra information	mark
1(a)	any **one** from: • add a water bath • heat screen • use LED • low energy bulb / described	ignore 'check temperature'	1
1(b)(i)	rate / number of bubbles decreases **or** less oxygen / gas released	accept converse with reference to increasing light **or** shorter distance ignore reference to rate of photosynthesis	1
1(b)(ii)	temperature / CO_2 (concentration)	accept 'it was too cool' **or** not enough CO_2 accept number of chloroplasts / amount of chlorophyll allow heat allow CO2 do **not** allow CO^2	1

Question 1 continues on the next page . . .

BL2HP

Question 1 continued . . .

<table>
<tr><th>question</th><th>Answers</th><th>extra information</th><th>mark</th></tr>
<tr><td>1(c)</td><td colspan="2">Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a ‘best-fit’ approach to the marking.</td><td>6</td></tr>
<tr><td></td><td colspan="3">
<table>
<tr><th>0 marks</th><th>Level 1 (1-2 marks)</th><th>Level 2 (3-4 marks)</th><th>Level 3 (5-6 marks)</th></tr>
<tr><td>No relevant content.</td><td>There is a brief description of at least 1 tissue or at least 1 function of an indicated part of the leaf.
The account lacks clarity or detail.</td><td>There is a clear description which includes at least 1 named tissue and at least 1 correct function described for an indicated part of the leaf.</td><td>There is a detailed description of most of the structures and their functions.</td></tr>
</table>
</td></tr>
<tr><td></td><td colspan="3">examples of responses:
• epidermis
• cover the plant
• mesophyll / palisade
• photosynthesises
• phloem
• xylem
• transport.
The following points are all acceptable but beyond the scope of the specification:
• (waxy) cuticle – reduce water loss
• epidermis – no chloroplasts so allows light to penetrate
• stomata / guard cells – allow CO_2 in (and O_2 out) or controls water loss
• palisade (mesophyll) – <u>many</u> chloroplasts to trap light
– near top of leaf for receiving more light
• spongy (mesophyll) – air spaces for rapid movement of gases</td></tr>
<tr><td>Total</td><td></td><td></td><td>9</td></tr>
</table>

4.4.1.2 Rate of photosynthesis

Answer 09 · Mark scheme

January 2013 | BL2HP | Original Q1 | Legacy

BL2HP

4.4.1.2 Rate of photosynthesis

Answer 10 · Mark scheme

June 2013 | BL2HP | Original Q5 | Legacy

Question 5

question	answers	extra information	mark
5(a)	LHS – carbon dioxide / CO_2	allow CO2 ignore CO^2	1
	RHS glucose / carbohydrate / sugar	in either order allow starch allow $C_6H_{12}O_6$ / C6H12O6 ignore $C^6H^{12}O^6$	1
	oxygen	allow O_2 /O2 ignore O^2 / O	1

Question 5 continues on the next page...

Question 5 continued...

question	answers	extra information	mark
5(b)	any **five** from: • factor 1: CO_2 (concentration) • effect - as CO_2 increases so does rate and then it levels off or shown in a graph • explanation: (graph increases) because CO_2 is the raw material or used in photosynthesis / converted to organic substance / named eg **or** (graph levels off) when another factor limits the rate. • factor 2: temperature • effect – as temperature increases, so does the rate and then it decreases or shown in a graph • explanation: (rise in temp) increases rate of chemical reactions / more kinetic energy **or** (decreases) because the enzyme is denatured.	accept points made via an annotated / labelled graph allow warmth / heat allow 'it peaks' for description of both phases allow molecules move faster / more collisions context must be clear = high temperature allow other factor plus effect plus explanation: eg light wavelength / colour / pigments / chlorophyll / pH / minerals / ions / nutrients / size of leaves 2nd or 3rd mark can be gained from correct description and explanation	5
Total			**8**

4.4.1.2 Rate of photosynthesis

Answer 11 · Mark scheme June 2015 | BL2HP | Original Q2 | Legacy

2			6	AO1 / AO2 / AO3 2.4, 2.4.1a,b,prac

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

0 marks	Level 1 (1–2 marks)	Level 2 (3–4 marks)	Level 3 (5–6 marks)
No relevant content.	The apparatus needed to measure the leaf is identified **or** the apparatus needed to measure light intensity is identified **or** an appropriate use of the tape measure is identified.	There is a description of a leaf being measured at different locations **or** light being measured at different locations.	There is a description of a leaf **and** light being measured at different locations **and** repetitions are included **or** a control variable is described **or** appropriate mathematical treatment of the data is described

examples of points made in the response:

- use of tape measure to produce transect
- transect placed coming out of shady area (eg woodland) into lighter area
- repeat transects
- samples at same height above ground
- samples at same aspect (N / E / S / W) on trees
- measurement of length, or width, of leaves using ruler
- measure several leaves at each location
- use of light meter to measure light intensity
- repeat measurements of light intensity on several days
- measure light intensities at same time of day
- calculate mean for each location
- plot graph of mean leaf length, or width, vs. light intensity

extra information

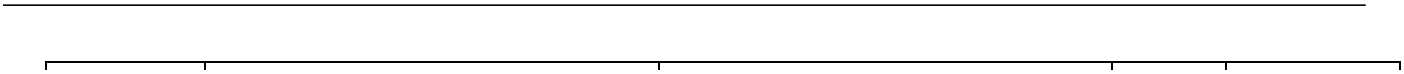
allow attempt to overcome other variables – eg soil water / soil pH / temperature

Total		**6**

4.4.1.2 Rate of photosynthesis

Answer 11 · Mark scheme

June 2015 | BL2HP | Original Q2 | Legacy



4.4.1.2 Rate of photosynthesis

Answer 12 · Mark scheme June 2016 | BL2HP | Original Q2 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2			6	AO1/2/3 2.3.1a/b/c/d +prac

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

0 marks	Level 1 (1–2 marks)	Level 2 (3–4 marks)	Level 3 (5–6 marks)
No relevant content.	A partial description of how the apparatus is set up **or** a description of how light is supplied **or** a simple description of how photosynthesis can be measured. **or** a control variable	A description of how the apparatus is set up **and** a description of how photosynthesis can be measured. **or** a description of how light intensity is varied **or** a control variable **or** any other relevant point	A description of how the apparatus is used to measure the **rate** of photosynthesis at different light **intensities** is given. For full marks reference must be made to a control variable **or** repeats

examples of the points made in the response

- apparatus set up:
  - weed in water in beaker
  - light shining on beaker
- method of varying the light intensity – eg changing distance of lamp from plant
- method of controlling other variables
  - use same pond weed **or** same length of pond weed
  - temperature: water bath or heat screen
  - CO_2
- leave sufficient time at each new light intensity before measurements taken
- method of measuring photosynthesis – eg counting bubbles of gas released or collecting gas & measuring volume in a syringe
- measuring **rate of photosynthesis** by counting bubbles for set period of time
- repetitions

extra information

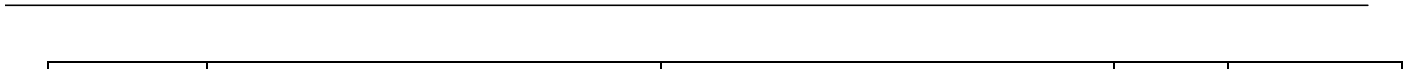
allow information in the form of a diagram

Total		6

4.4.1.2 Rate of photosynthesis

Answer 12 · Mark scheme

June 2016 | BL2HP | Original Q2 | Legacy



4.4.1.2 Rate of photosynthesis

Answer 13 · Mark scheme June 2017 | BL2HP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)	carbon + water ⟶ glucose + oxygen dioxide	LHS = 1 mark RHS = 1 mark allow sugar instead of glucose, ignore starch allow correct formulae: H_2O, CO_2, $C_6H_{12}O_6$ and O_2 if words **and** formulae given, accept correct words and ignore incorrect formulae ignore balancing ignore light / heat / energy / chlorophyll on LHS do **not** allow light / heat / energy on RHS	2	AO1 2.3.1a
4(b)(i)	16	allow answers in range 15.8 to 16.2	1	AO2 2.3 2.3.1c
4(b)(ii)	25 (%)	ignore 0.25 allow ecf from answer to **bi**	1	AO2 2.3 2.3.1c
4(b)(iii)	no extra photosynthesis **or** maximum rate is reached (so) no extra yield **or** less profit **or** not cost-effective **or** waste of money	ignore graph levels off allow CO_2 not limiting **or** another factor is limiting (the rate of photosynthesis) ignore cost unqualified	1 1	AO2/AO3 2.3 2.3.1c

4.4.1.2 Rate of photosynthesis

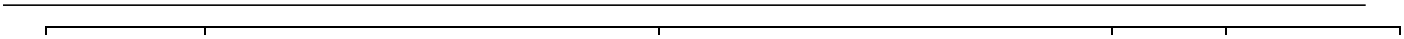
Answer 13 · Mark scheme

4(b)(iv)	increased temperature increased light (intensity)	allow use of a heater allow turn on lamps allow increased minerals / ions / salts / water / correct named example if no other marks awarded allow one mark for temperature **and** light	1 1	AO1 2.3, 2.3.1c,d
Total			**8**	

4.4.1.2 Rate of photosynthesis

Answer 13 · Mark scheme

June 2017 | BL2HP | Original Q4 | Legacy



4.4.1.2 Rate of photosynthesis

Answer 14 · Mark scheme June 2018 | 8461/2H | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	there is an uneven distribution of dandelions **or** (more) representative / valid **or** avoid bias **or** more accurate / precise mean	 ignore accurate / precise unqualified ignore repeatability / reproducibility / reliability / fair test	1	AO1 4.7.2.1
04.2		an answer of 3.3×10^5 scores **5** marks an answer of 330 000 scores **4** marks		AO2 4.7.2.1
	(correct mean per m^2 =) 6 or 6.0		1	
	(correct field area =) 55 000 (m^2)		1	
	mean x area – eg 6(.0) × 55 000	allow incorrect calculated values for mean and / or field area	1	
	330 000	allow correct calculation from previous calculation	1	
	3.3×10^5	allow calculated value in standard form	1	

4.4.1.2 Rate of photosynthesis

Answer 14 · Mark scheme

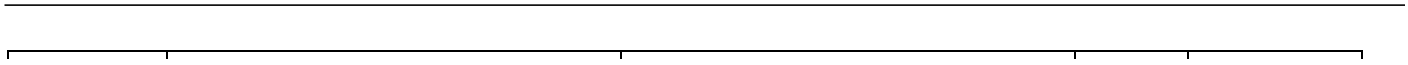
June 2018 | 8461/2H | Original Q4

Question	Answers		Mark	AO / Spec. Ref.
04.3	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.		5–6	AO3
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.		3–4	AO2
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.		1–2	AO1
	No relevant content		0	
	Indicative content • placing of quadrat • large number of quadrats used • how randomness achieved – eg table of random numbers **or** random number button on calculator **or** along transect • quadrats placed at coordinates **or** regular intervals along transect • in each of two areas of different light intensities **or** transect running through areas of different light intensity • for each quadrat count number of dandelions • for each quadrat measure light intensity • compare data from different light intensity to access **level 3** the key ideas of using a large number of quadrats randomly, or along a transect, and counting the number of dandelions in areas of differing light intensity need to be given to produce a valid outcome			4.7.2.1
04.4	any **two** from: • temperature • water • (soil) pH • minerals / ions • wind • herbivores	allow heat allow moisture / rain allow acidity allow eg magnesium ions **or** nitrate allow salts / nutrients allow trampling ignore carbon dioxide ignore space ignore competition unqualified do **not** accept oxygen	2	AO1 4.4.1.2 4.7.1.2
Total			**14**	

4.4.1.2 Rate of photosynthesis

Answer 14 · Mark scheme

June 2018 | 8461/2H | Original Q4



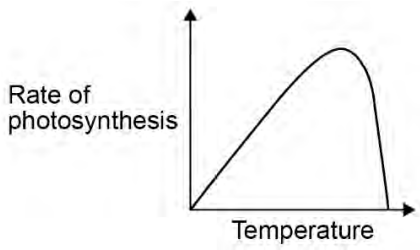
4.4.1.2 Rate of photosynthesis

Answer 15 · Mark scheme June 2019 | 8461/1H | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	LHS: carbon dioxide **and** water RHS: glucose	words take precedence over symbols allow correct symbols (ignore balancing) in any order do **not** accept starch ignore carbohydrates / sugar	1 1	4.4.1.1 AO1
03.2	power output of bulb		1	4.4.1.2 AO2
03.3	any **two** from: • repeat **and** calculate a mean **or** repeat **and** to eliminate anomalies • control the (water) temperature • control the concentration of carbon dioxide • control the distance of the bulb from the pondweed • control the mass / length / species / age of the pondweed • give pondweed time to equilibrate	ignore do a control experiment unqualified allow a method of controlling (water) temperature allow a method of controlling carbon dioxide concentration allow use the same piece of pondweed allow do experiment with the bulb off / in the dark	2	4.4.1.2 AO3
03.4	3.3 (cm^3/hour)		1	4.4.1.2 AO2

4.4.1.2 Rate of photosynthesis

Answer 15 · Mark scheme June 2019 | 8461/1H | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	correct scale **and** axis labelled	max **3** marks for bar chart	1	4.4.1.2 AO2
	all points plotted correctly	allow points plotted to within ± ½ small square allow 3 or 4 correct plots for **1** mark allow correct plot from incorrect value calculated in question **03.4**	2	
	correct curved line of best fit	ignore line extended beyond 60 / 250 (W) ignore line joined point to point with straight lines	1	
03.6	correct answer from their line drawn on **Figure 4**	allow ± ½ small square tolerance allow 1.8 / 1.9 if no line of best fit or incorrect graph is drawn	1	4.4.1.2 AO2
03.7			1	4.4.1.2 AO2
Total			**12**	

4.4.1.2 Rate of photosynthesis

Answer 15 · Mark scheme

June 2019 | 8461/1H | Original Q3

Answer 16 · Mark scheme

November 2020 | 8461/1H | Original Q1

The full source mark scheme begins on page 50. Follow original question 1 in that document.

4.4.1.2 Rate of photosynthesis

Answer 17 · Mark scheme

June 2023 | 8461/1H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec Ref.
06.1	(*lhs*) H_2O + CO_2 **and** (*rhs*) O_2	in either order	1	AO1 4.4.1.1

Question	Answers	Extra information	Mark	AO / Spec Ref.
06.2	from 0 to 5 000 lux		1	AO3 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec Ref.
06.3	any **one** from: • use (different) coloured bulb(s) / LED(s) • use (different) coloured filter(s) in front of lamp • put (different) coloured transparent material(s) over lamp / beaker	allow named transparent material(s)	1	AO2 4.4.1.2 RPA6

Question	Answers	Extra information	Mark	AO / Spec Ref.
06.4	*independent* colour of light *dependent* time (taken for 10 leaf discs to reach the surface of the solution)	allow wavelength of light ignore colour of filter / bulb / lamp	1 1	AO2 4.4.1.1 4.4.1.2 RPA6

4.4.1.2 Rate of photosynthesis

Answer 17 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec Ref.
06.5	any **one** from: • so that discs would sink (to the bottom of the beaker) • so any gas (that makes the discs rise) is from photosynthesis • air is a gas so any left in discs would add to the oxygen produced by photosynthesis	allow leaf for disc throughout allow so the discs do not float ignore reference to carbon dioxide allow as a control variable	1	AO2 4.4.1.1 4.4.1.2 RPA6

Question	Answers	Extra information	Mark	AO / Spec Ref.
06.6	(sodium hydrogencarbonate) provides / releases carbon dioxide (carbon dioxide is used) for photosynthesis	ignore (sodium hydrogencarbonate) contains carbon dioxide ignore provides water	1 1	AO2 4.4.1.1 4.4.1.2 RPA6

Question	Answers	Extra information	Mark	AO / Spec Ref.
06.7	oxygen was produced in photosynthesis oxygen / gas is trapped in / around disc / leaf	allow bubbles are trapped in / around the disc / leaf allow oxygen / gas (makes leaf discs) less dense than solution / water allow the oxygen / gas under the disc / leaf pushes the disc / leaf up	1 1	AO1 AO2 4.4.1.1 4.4.1.2 RPA6

4.4.1.2 Rate of photosynthesis

Answer 17 · Mark scheme

June 2023 | 8461/1H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec Ref.
06.8	to absorb / use many / more colours / wavelengths of light	allow to increase the rate of photosynthesis ignore to absorb as much light as possible do **not** accept to absorb all colours / wavelengths of light	1	AO2 4.4.1.1 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec Ref.
06.9	chlorophyll absorbs most **or** a lot of blue light	if neither mark awarded allow **1** mark for chlorophyll absorbs more blue light (than green light)	1	AO3
	chlorophyll absorbs least **or** very little **or** not much green light	allow chlorophyll reflects most of the green light	1	AO3
	(so) discs in blue light took the least time to rise (to surface) because they photosynthesised faster / more **or** (so) discs in green light took the most time to rise (to surface) because they photosynthesised slower / less		1	AO2
	use of data (from **Figure 10** and **Table 6**) eg approximately 80% of blue light absorbed		1	AO2 4.4.1.1 4.4.1.2

Total Question 6	15

4.4.1.2 Rate of photosynthesis

Answer 18 · Mark scheme

June 2023 | 8461/2H | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec Ref.
06.1	(0 to 6h): in the dark so (only) respiration occurs	ignore reference to animals allow no / limited light so (only) respiration occurs allow night(time) so (only) respiration occurs	1	AO2 4.7.1.2 4.7.2.2 4.4.1.2 4.4.2.1
	(respiration) produces carbon dioxide		1	
	(8 to 12h): in the light so photosynthesis (rate) is faster than respiration (rate)	allow in the light so more photosynthesis than respiration allow day(time) so more photosynthesis than respiration do **not** accept no respiration	1	
	idea of net / overall uptake of carbon dioxide	allow uptake of carbon dioxide by photosynthesis is greater / faster than output by respiration	1	

Question	Answers	Extra information	Mark	AO / Spec Ref.
06.2	field of maize only takes in carbon dioxide for 6 months of the year (compared to all year)	answers must be comparative allow converse argument allow maize takes in carbon dioxide for a shorter amount of time	1	AO3 4.7.2.4 4.7.3.4 4.7.3.3
	(and) field of maize takes in less carbon dioxide per day than rainforest		1	

4.4.1.2 Rate of photosynthesis

Answer 18 · Mark scheme

June 2023 | 8461/2H | Original Q6

Question	Answers	Extra information	Mark	AO / Spec Ref.
06.3	for comparison		1	AO2
	(because) different areas started with different numbers (of species)	do **not** accept (because) different areas started with different numbers of trees	1	AO3 4.7.2.4 4.7.3.1 4.7.3.4 4.7.3.6 4.7.3.3

Question	Answers	Extra information	Mark	AO / Spec Ref.
06.4	any **one** from: • number of tree species increased rapidly at first • the number of tree species increases more slowly later • rate of increase of number of tree species decreases with time • beyond about 50 years there were more tree species than in the original rainforest • there was (great) variability of number of tree species from one study area to another at the same time	ignore answers referring to numbers of trees unqualified allow it takes 45 to 55 years for the forest to recover (the number of species) ignore biodiversity increases	1	AO3 4.7.2.4 4.7.3.1 4.7.3.6 4.7.3.3

4.4.1.2 Rate of photosynthesis

Answer 18 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec Ref.
06.5	more / different types of food available	ignore more food available	1	AO2 4.7.2.4 4.7.3.1 4.7.3.6 4.7.3.3
	more / different types of habitat / shelter **or** nest sites available	allow more / different habitats	1	

Total Question 6	**11**

4.4.1.2 Rate of photosynthesis

Answer 19 · Mark scheme

June 2024 | 8461/1H | Original Q7

Question 7

Question	Answers	Extra information	Mark	AO / Spec Ref.
07.1	***Leaf 1 or covered with black paper*** no light so no photosynthesis (occurs) ***Leaf 2 or covered with transparent plastic*** no carbon dioxide so no photosynthesis ***Leaf 3 or not covered*** light and carbon dioxide present so leaf can photosynthesise ***for either Leaf 1 / 2*** (so) glucose not made (and therefore) glucose / sugar cannot be converted to starch	ignore reference to water ignore reference to carbon dioxide ignore no limiting factors allow converse for **Leaf 3** if neither marking points 4 and 5 awarded, allow starch (previously present) has been broken down for **1** mark	1 1 1 1 1	AO3 AO3 AO3 AO2 AO2 4.4.1.1 4.4.1.2 4.4.1.3

Question	Answers	Extra information	Mark	AO / Spec Ref.
07.2	(green) starch / present / positive **and** (white) no starch **or** not present **or** negative	both required for **1** mark allow blue-black / black **or** dark blue allow yellow / orange / brown	1	AO3 4.4.1.2

4.4.1.2 Rate of photosynthesis

Answer 19 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec Ref.
07.3	green part contains chlorophyll **and** white part does not (so) light is absorbed by green part (but not by white part) so photosynthesis occurs and starch can be formed	ignore chloroplasts allow (so) light is absorbed by chlorophyll / chloroplasts so photosynthesis occurs and starch can be formed allow converse for white part ignore colours of starch test if referenced	1 1	AO2 AO1 4.4.1.1 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec Ref.
07.4	magnesium	allow Mg / Mg^{2+} allow nitrate / iron allow other correct named ions	1	AO1 4.3.3.1

Question	Answers	Extra information	Mark	AO / Spec Ref.
07.5	chlorosis		1	AO1 4.3.3.1

Question	Answers	Extra information	Mark	AO / Spec Ref.
07.6	(measure the) volume (of oxygen) released / produced in a given time **or** (count / number of) bubbles released / produced in a given time	allow answers in terms of a specific time ignore measure the amount (of oxygen) released in a given time	1	AO1 4.4.1.2 4.4.1.1 RPA6

4.4.1.2 Rate of photosynthesis

Answer 19 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec Ref.
07.7	(a factor that) if increased would increase the rate (of a reaction) **or** (a factor that) prevents the rate (of a reaction) increasing	allow answers in terms of (a) named factor(s) allow (a factor that) prevents the maximum rate (of a reaction) being reached	1	AO1 4.4.1.2 4.4.1.1

Question	Answers	Extra information	Mark	AO / Spec Ref.
07.8	increasing temperature while keeping the carbon dioxide (concentration) constant increases the rate (of photosynthesis)	allow increasing the carbon dioxide (concentration) while keeping temperature constant increases the rate (of photosynthesis)	1	AO3 4.4.1.2 4.4.1.1
	increasing the temperature increases the movement of the molecules / particles / substrate **or** increasing the temperature increases the rate of enzyme activity	allow increasing the temperature increases the kinetic energy of the molecules / particles / substrate allow increasing the temperature increases the frequency of collisions between molecules / particles	1	
	increasing carbon dioxide concentration increases (the concentration of) substrate / reactants		1	
	all rates plateau at a certain point due to another factor being limiting	allow all rates plateau at a certain point due to chlorophyll being limiting do **not** accept all rates plateau at a certain point due to light being limiting	1	

Question	Answers	Extra information	Mark	AO / Spec Ref.
07.9	light intensity $\propto \frac{1}{\text{distance}^2}$		1	AO2 4.4.1.2

Total Question 7	17

4.4.1.2 Rate of photosynthesis

Answer 20 · Mark scheme

June 2025 | 8461/1H | Original Q4

Question 4

Question	Answers	Extra information	Mark	AO / Spec Ref.
04.1	temperature		1	AO2 4.4.1.2 RPA6

Question	Answers	Extra information	Mark	AO / Spec Ref.
04.2		allow correct calculation in other units eg bubbles per minute / hour		AO1 4.4.1.2 RPA6
	$\frac{10}{43}$ **or** $\frac{1}{43} \times 10$		1	
	0.23255…		1	
	0.233	allow student's incorrectly calculated value to 3 significant figures allow use of other values for time from **Table 4**	1	
	(unit) bubbles per second	unit must be consistent with student's answer for MP3	1	

Question	Answers	Extra information	Mark	AO / Spec Ref.
04.3		allow converse for 10 °C if clearly stated		
	rate / photosynthesis is faster / higher (at 40 °C)	allow as the temperature increases, the rate (of photosynthesis) increases	1	AO3
	reactants / particles / molecules / enzymes have greater (kinetic) energy	allow reactants / particles / molecules / enzymes move faster	1	AO2
	(so) collide more frequently	allow (so) more collisions in a given time allow more <u>successful</u> collisions	1	AO2 4.4.1.2 4.2.2.1

4.4.1.2 Rate of photosynthesis

Answer 20 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec Ref.
04.4	any **two** from: • light intensity / level • colour / wavelength of light • carbon dioxide (concentration) • (mass of) chlorophyll	if neither point awarded allow **1** mark for light unqualified allow number of chloroplasts ignore water / humidity do **not** accept wind	2	AO1 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec Ref.
04.5	collect gas / oxygen in a (gas) syringe **or** collect gas / oxygen in an inverted measuring cylinder	allow bubbles for gas / oxygen do **not** accept incorrect gas allow measure the volume of gas / oxygen in a (gas) syringe ignore use a gas syringe allow measure the volume of gas / oxygen in an inverted measuring cylinder ignore collect gas / oxygen in a measuring cylinder ignore use an inverted measuring cylinder allow other correct methods	1	AO3 4.4.1.2 RPA6

Question	Answers	Extra information	Mark	AO / Spec Ref.
04.6	any **two** from: • reference to a gardening manual / website / app • take (infected plants) to a laboratory / scientist / expert • use testing kits that contain monoclonal antibodies	ignore use / search the internet unqualified	2	AO1 4.3.3.1

4.4.1.2 Rate of photosynthesis

Answer 20 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec Ref.
04.7	(rose) black spot	allow other correct diseases such as rust do **not** accept nitrate / magnesium deficiency do **not** accept tobacco mosaic virus **or** TMV	1	AO1 4.3.3.1

Question	Answers	Extra information	Mark	AO / Spec Ref.
04.8	a shortage of magnesium (ions)	allow a shortage of nitrate / iron (ions)	1	AO1 4.3.1.4 4.3.3.1
	which causes chlorosis **or** (so) less chlorophyll **or** (magnesium is needed) to make chlorophyll **OR** lack of light (1) causes chlorosis **or** causes chlorophyll to break down (1)	ignore chlorosis unqualified ignore fewer chloroplasts allow (nitrate / iron is needed) to make chlorophyll	1	

Total Question 4	16

4.4.1.2 Rate of photosynthesis

AQA

GCSE
BIOLOGY
8461/1H

Paper 1 Higher Tier

Mark scheme

June 2020

Version: 1.0 Final

206G8461 1H/MS

4.4.1.2 Rate of photosynthesis

MARK SCHEME – GCSE BIOLOGY – 8461/1H – JUNE 2020

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement
- the Assessment Objectives, level of demand and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. Full marks can, however, be given for a correct numerical answer, without any working shown.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ecf in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do <u>not</u> accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

4. Level of response marking instructions

Extended response questions are marked on level of response mark schemes.

- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

Before you apply the mark scheme to a student's answer, read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

4.4.1.2 Rate of photosynthesis

Step 1: Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer.

When assigning a level you should look at the overall quality of the answer. Do **not** look to penalise small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2 but be awarded a mark near the top of the level because of the level 3 content.

Step 2: Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this.

The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do **not** have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

You should ignore any irrelevant points made. However, full marks can be awarded only if there are no incorrect statements that contradict a correct response.

An answer which contains nothing of relevance to the question must be awarded no marks.

4.4.1.2 Rate of photosynthesis

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1		allow correct chemical symbols ignore any attempt at balancing equation ignore light / chlorophyll		AO1 4.4.1.1
	before arrow carbon dioxide **and** water	either order	1	
	after arrow glucose	ignore sugar / carbohydrate do **not** accept starch	1	
01.2		ignore description of subsequent parts of the photosynthesis reaction		AO1 4.1.1.2 4.4.1.1
	<u>light</u>	allow sun<u>light</u> ignore sun	1	
	(light) is captured / trapped / absorbed by chlorophyll / chloroplasts	allow (light) is used by chlorophyll / chloroplasts	1	
01.3	$\frac{18.5 + 19.3 + 19.5}{3}$ **or** $\frac{57.3}{3}$		1	AO2 4.4.1.2 RPA 6
	19.1 (cm^3/hour)	allow an answer correctly calculated using only two correct values	1	
01.4	a ring around 14.2	allow clear indication of correct result	1	AO3 4.4.1.2 RPA 6

4.4.1.2 Rate of photosynthesis

01.5	any **one** from: • scale / value was misread • there was air / oxygen in the syringe / measuring cylinder / apparatus • the lamp / light was moved • temperature changed • had different mass / length of pondweed • pondweed had not acclimatised	ignore human error ignore references to counting bubbles or time allow measurement error allow light intensity changed ignore different bulb / lamp unqualified	1	AO3 4.4.1.2 RPA 6
01.6	did not use it in calculation (of mean)		1	AO3 4.4.1.2 RPA 6
01.7	any **one** from: • light (intensity) • carbon dioxide (concentration) • pondweed size / amount • pondweed species	do **not** accept temperature ignore time allow distance / power / colour of lamp / light allow same (piece of) pondweed	1	AO3 4.4.1.2 RPA 6
01.8	enzyme(s) lose the shape of the active site	allow enzyme(s) (start to) denature allow enzyme(s) destroyed / damaged do **not** accept enzyme(s) killed	1	AO2 4.2.2.1

4.4.1.2 Rate of photosynthesis

01.9	y-axis labelled '(rate of) photosynthesis in cm^3/hour'		1	AO2 4.4.1.2 RPA 6
	suitable scale on y-axis	must take up half or more of grid provided	1	
	all points plotted to within ± ½ small square	allow 3 or 4 correct plots for **1** mark ignore any attempt to plot a point at 20 °C	2	
	correct curved line of best fit	ignore line joined point to point with straight lines ignore extrapolation	1	
Total			**16**	

4.4.1.2 Rate of photosynthesis

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	movement / spreading out of molecules / particles	allow movement / spreading out of (named) substances / chemicals / gases / liquids ignore reference to membranes / cells	1	AO1 4.1.3.1
	from (an area of) high(er) concentration to (an area of) low(er) concentration	allow down / with the concentration gradient ignore along / across the concentration gradient do **not** accept movement from / to a concentration gradient	1	
02.2	increased carbon dioxide concentration in the air		1	AO2 4.1.3.1 4.2.3.2
	increased number of stomata that are open		1	

4.4.1.2 Rate of photosynthesis

02.3	**Level 3:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1 4.1.3.1 4.2.2.2 4.2.2.3
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	

	Indicative content
	• (many) alveoli
	  • provide a large(r) surface area (**:** volume)
	
	• capillaries are thin
	  or alveoli / capillary walls are thin **or** one cell thick
	  or capillaries are close to the alveoli
	  • which provides short diffusion path (for oxygen / carbon dioxide)
	
	• breathing (mechanism) moves air in and out
	or lungs are ventilated
	  • to bring in (fresh) oxygen
	  • to remove carbon dioxide
	  • to maintain a concentration / diffusion gradient
	
	• large capillary network (around alveoli)
	or good blood supply
	  • to remove oxygen(ated blood) quickly
	  • to bring carbon dioxide to the lungs quickly
	  • to maintain a concentration / diffusion gradient		

4.4.1.2 Rate of photosynthesis

02.4	osmosis	allow diffusion	1	AO1 4.1.3.1 4.2.3.2 4.1.3.2
02.5	active transport (because) energy is needed (to move nitrate ions) from a low(er) concentration (in the soil) to a high(er) concentration (in the root / cell)	 allow (to move nitrate ions) against / up the concentration gradient allow (because) there is a lower concentration (of nitrate ions) in the soil **or** (because) there is a higher concentration (of nitrate ions) in the root / cell ignore reference to amount / number of nitrate ions ignore along / across the concentration gradient do **not** accept if reference to molecules / atoms moving	1 1 1	AO3 AO2 AO2 4.1.1.3 4.2.3.2 4.1.3.3
Total			**14**	

4.4.1.2 Rate of photosynthesis

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	any **two** from: (both have) • cytoplasm • (cell) membrane • DNA / genetic material • ribosomes	ignore reference to shape allow RNA ignore genetic information if no other mark awarded allow sub-cellular structures for **1** mark if no other mark awarded allow correct cellular process, e.g. respiration for **1** mark	2	AO2 4.1.1.1 4.1.1.2 4.1.2.1
03.2	any **three** from: • prokaryotic cell is smaller • prokaryotic cell has no mitochondria • prokaryotic cell has no nucleus **or** DNA is free in the cytoplasm **or** genetic material is free in the cytoplasm • prokaryotic cell has a single loop of DNA **or** prokaryotic cell has a single loop of genetic material • prokaryotic cell has plasmids	allow converse for eukaryotic cells allow reference to bacterium instead of prokaryotic cell ignore reference to features not shown in Figure **5** if neither mark awarded, allow prokaryotic cell has no membrane-bound organelles ignore genetic information ignore genetic information ignore circular / rings of DNA allow prokaryotic cells have smaller ribosomes	3	AO2 4.1.1.1 4.1.1.2 4.1.2.1

4.4.1.2 Rate of photosynthesis

03.3	1 µm = 0.001 mm **or** 1 mm = 1000 µm **or** 0.05 mm = 50 µm **or** 0.05 × 1000 (1:) 50	 do **not** accept if a unit is given	1 1	AO2 4.1.1.1 4.1.1.2
03.4	mitosis	correct spelling only	1	AO1 4.1.2.2
03.5	35%		1	AO2 4.1.2.2
03.6	 (stage 1) DNA / chromosomes replicate / duplicate mitochondria / ribosomes / sub-cellular structures increase in number **or** mitochondria / ribosomes / sub-cellular structures replicate (stage 2) one set of chromosomes is pulled / moved to each end of the cell (stage 3) the cytoplasm **and** cell membrane divides (to form two cells)	ignore names of the stages of the cell cycle ignore genetic material ignore DNA / chromosomes double / reproduce allow cytoplasm increases ignore cell grows unqualified allow one of each chromosome is pulled / moved to each end of the cell ignore nucleus divides allow cytoplasm divides **and** (new) cell membranes form ignore nucleus divides	 1 1 1 1	AO1 4.1.2.2
Total			**13**	

4.4.1.2 Rate of photosynthesis

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	fatty acids		1	AO1 4.2.2.1
	glycerol		1	4.4.2.3
04.2	enzyme binds to the substrate because they are complementary (shapes)	allow enzyme joins to the substrate because they fit together exactly allow enzyme joins to the substrate because the substrate fits the active site ignore reference to specificity do **not** accept same shape	1	AO2 4.2.2.1
	(so) substrate is broken down (into products)	allow (so) substrate splits (into products) ignore products are formed, unqualified	1	
	(so) products are released **or** enzyme is not changed	allow enzyme is not used up allow reference to activation energy for either marking point 2 **or** marking point 3	1	
04.3	each <u>active site</u> has a specific shape (so only fits one type of lipid molecule)	allow each <u>active site</u> is a different shape do **not** accept reference to the substrate having an active site	1	AO2 4.2.2.1
04.4	add Benedict's (solution / reagent to the liquid)		1	AO1 4.2.2.1 RPA 4
	boil / heat	allow any temperature of 65 °C or above	1	
	(if glucose is present the blue) colour changes to yellow / green / orange / brown / (brick)red		1	

4.4.1.2 Rate of photosynthesis

04.5	add iodine solution / reagent (to the liquid) (if starch is present) it changes colour to blue / black (from yellow / orange / brown)	allow add a drop of iodine ignore iodine unqualified	1 1	AO1 4.2.2.1 RPA 4
04.6	glucose from photosynthesis (excess) glucose converted to starch	do **not** accept starch made in photosynthesis allow (excess) glucose is stored as starch	1 1	AO2 4.2.2.1 4.4.1.1 4.4.1.3 4.4.2.3
04.7	starch (stores) have been converted to glucose (so the glucose can be) used for respiration / (named) metabolic reactions **or** (so the glucose can be) used to release energy (because) there is no light to make (new / more) glucose by photosynthesis	ignore reference to residual glucose from previous photosynthesis do **not** accept idea of energy being produced / created / made	1 1 1	AO3 4.4.1.1 4.4.2.1 4.4.1.3
04.8	any **one** from: • test roots / stems of plants (in the light and dark) • test other species of plant • measure the concentrations of glucose **and** starch • vary the time in the dark / light • test variegated leaves	do **not** accept reference to changing the independent variable allow test other parts of the plants allow test other types of plant ignore mass / amount allow any other valid extension ignore repeats	1	AO3 4.4.1.2 4.4.1.3
Total			**17**	

4.4.1.2 Rate of photosynthesis

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	mechanical	allow physical allow structural	1	AO3 4.3.3.2
05.2	any **one** from: • to deter herbivores • to prevent animals damaging it	ignore to injure animals, unqualified allow to deter animals eating it do **not** accept to deter predators	1	AO2 4.3.3.2
05.3	chemical		1	AO3 4.3.3.2

4.4.1.2 Rate of photosynthesis

05.4	any **two** from : • lack of magnesium (ions) (1) (so) not enough chlorophyll for (efficient) photosynthesis (1) (so) not enough glucose to make proteins for growth **or** not enough glucose to release energy for growth (1) • infection by pathogen / bacteria / virus / fungus (1) (so) leaves become discoloured / yellow so less photosynthesis (1) (so) not enough glucose to make proteins for growth **or** not enough glucose to release energy for growth (1) • infected by aphids (1) (which) remove sugars from phloem (1) (so) not enough glucose to make proteins for growth **or** not enough glucose to release energy for growth (1) • lack of (available) light (1) (so) chlorophyll breaks down (1) (so) not enough glucose to make proteins for growth **or** not enough glucose to release energy for growth (1)	allow (so) lack of chlorophyll produced causes yellow leaves (1), (so) not enough photosynthesis to produce glucose which is used to make proteins for growth (1) allow correctly named pathogen allow has rose black spot / TMV allow other symptoms of named pathogens / disease award once only award once only award once only	5	AO2 4.3.3.1 4.3.1.1 4.3.1.2 4.3.1.4 4.4.1.1 4.4.1.2 AO1 4.4.2.3 4.4.1.3

4.4.1.2 Rate of photosynthesis

05.5	(bacteria) obtain glucose / sugar (from the plant) (glucose used) for respiration **or** (glucose used) for making other named substances	 allow (glucose used) to release energy	1 1	AO3 AO2 4.2.3.2 4.4.1.3
05.6	(gorse plant) obtains nitrate (ions) needed for amino acids / proteins	 allow needed to make chlorophyll / DNA	1 1	AO2 4.1.3.3 4.4.2.3 AO1 4.3.3.1
05.7	willow bark		1	AO2 4.3.1.9
Total			**13**	

4.4.1.2 Rate of photosynthesis

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	any **two** from: • BMI / morphology / obesity level • smoking habits • diet • medication • family history of liver disease • fitness levels • ethnicity • area of UK they live in	ignore genetic factors allow mass / weight **and** height allow previous drinking habits allow medical conditions allow drug use allow level of exercise allow race	2	AO3 4.2.2.6
06.2	2.55 – 1.60 (= 0.95) $\left(\frac{0.95}{2.55} \times 100 = \right)$ 37 (.2549019608…) (%)	allow 1.60 – 2.55 (= –0.95) allow value for with meals in range 1.60 to 1.65 (for 1.60) allow answer correctly calculated from values in ranges 1.60 to 1.65 and 2.50 to 2.60 allow – 37(.2549019608...)(%)	1 1	AO2 4.2.2.6
06.3	12 × 2 × 7 = 168 (g/week) 1.8	 allow in range 1.8-1.9 allow correct reading from a calculation that omits the 2 **or** the 7 do **not** accept if a unit is given	1 1	AO2 4.2.2.6

4.4.1.2 Rate of photosynthesis

06.4	any **two** from: • consuming alcohol increases the RR (with / without meals) **and** supporting data • consuming less than 50 g/week of alcohol with meals does not increase the RR • even (small amounts of alcohol at) 25 g/week increases the RR if not with meals	allow risk for RR throughout allow data in terms of number of glasses of wine allow increasing alcohol consumption increases the RR at an increasing rate allow any value between 35 and 60 g/week	2	AO3 4.2.2.6
06.5	any **two** from: • large number in survey • long term / 15 year survey • well controlled	allow 800 000 in survey if neither mark awarded allow large study allow many controls	2	AO3 4.2.2.6
06.6	any **one** from: • people underestimate / overestimate alcohol consumption • people may change (lifestyle / drinking) habits over time • some people may drink all their weekly alcohol at once	allow people lie about alcohol consumption **or** people lie about other named control variables ignore survey only tested women	1	AO3 4.2.2.6

4.4.1.2 Rate of photosynthesis

06.7	**Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	3-4	AO2 4.4.2.3 4.2.2.1
	Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.	1-2	AO1 4.4.2.2 4.2.2.6 4.2.2.5 4.5.3.3
	No relevant content	0	
	Indicative content Responses may refer to either total or partial liver failure • no bile made (in the liver) ○ fats / lipids are not emulsified ○ surface area of fats / lipids not increased ○ pH of small intestine will not be alkaline / neutralised ○ enzymes (in small intestine) will not work effectively **or** (named) food not digested / absorbed ○ so may lose weight • lactic acid not broken down / oxidised ○ accumulation of lactic acid in blood / body ○ lactic acid is toxic **or** body will be poisoned ○ oxygen debt higher / prolonged ○ so muscle pain / fatigue • proteins / amino acids will not be broken down (in liver) ○ (amino acids) not deaminated ○ amino acids not made into urea **or** will not form ammonia ○ (however) any ammonia formed is toxic ○ so accumulation of amino acids in blood / body • liver does not break down / remove other toxins (like alcohol) ○ toxins accumulate in blood / body ○ body will be poisoned ○ so pain **or** jaundice **or** swollen liver **or** portal hypertension occurs • glycogen stores will not be formed ○ cannot control blood glucose ○ so hyperglycaemia / hypoglycaemia / diabetes / coma may occur		

Total			**15**

4.4.1.2 Rate of photosynthesis

Question	Answers	Extra information	Mark	AO / Spec.Ref.
07.1		ignore add mAbs and dye to slide (unbound)		AO2 4.3.2.2
	bind fluorescent dye to mAbs		1	
	put (bound) fluorescent mAbs on the slide (and rinse off)		1	
	mAbs will bind to Candida albicans / pathogens and show up under the microscope	allow mAbs will bind to Candida albicans / pathogens and show up under UV (lamp)	1	
07.2	more Candida albicans / pathogens will be engulfed / killed by phagocytes / white blood cells	allow Candida albicans / pathogens will be engulfed / killed by phagocytes / white blood cells more quickly do **not** accept white blood cells produce antibodies do **not** accept lymphocytes engulf Candida albicans	1	AO2 4.2.2.3 4.3.1.6 4.3.1.7
	therefore less damage to cells / tissues / organs	ignore less toxin released (by Candida albicans)	1	

07.3	**Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.		4-6	AO1 4.3.1.9
	Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.		1-3	
	No relevant content		0	
	Indicative content • given first to healthy volunteers ○ at (very) low dose ○ to test it is safe **or** to test for toxicity **or** to check for any side effects • then to some patients (with the disease) **or** people with the disease ○ to test for the correct / optimum dose ○ to check for any side effects ○ to test for efficacy **or** to test if it works ○ in a double blind trial ○ where neither patients nor doctors know who has the mAbs and who has a placebo (or alternative treatment) • reference to large trial **or** long duration **or** control variables			
07.4	any **one** from: • (the body will) not reject the mAbs **or** (the body is) less likely to reject the mAbs • mouse mAbs are (more likely to be) rejected • the human lymphocytes have already responded to that infection / cancer cell so they are known to work against the disease	do **not** accept idea of rejection of cells	1	AO3 4.3.2.2 4.3.2.1 4.3.1.6
Total			**12**	

4.4.1.2 Rate of photosynthesis

Answer 16 · Examiner comments November 2020 | 8461/1H | Original Q1

Question 1 (standard demand)

The reference to 'energy' in **01.2** triggered some confusion, with some students discussing respiration rather than considering the context of photosynthesis.

In **01.5**, reference to 'human error' on its own was insufficient and students should always be reminded to add qualification. The concept of denaturation in **01.8** was misunderstood by several students (nearly 60% of students scored no marks), with plants denaturing, cells denaturing and 'it' denaturing commonly seen.

Students are advised to read and follow all of the instructions given when asked to draw a graph, as in **01.9**, many students missed key tasks despite them being listed clearly. Students need to understand how to draw a line/curve of best fit when the plots do not fall on a straight line and students generally could be more accurate when plotting points, particularly those that are not whole numbers. A few students plotted the three individual repeats for each temperature rather than the mean, which meant that no plotting marks could be awarded.

Answer 17 · Examiner comments June 2023 | 8461/1H | Original Q6

Question 6 (Standard, standard/high and high demand)

06.1 This question was well answered, with just over 87% gaining the mark. It is particularly pleasing to see that students are taking care with the size of the letters in chemical formulae and the correct use of subscript.

06.2 Almost 83% of students correctly identified 0 to 5000 lux as being the correct representation.

Y

4.4.1.2 Rate of photosynthesis

Answer 17 · Examiner comments June 2023 | 8461/1H | Original Q6

06.3 While many students had the idea to use some form of coloured transparent material to change the colour of the light shining on the leaf discs, unfortunately, some of those students didn't state where this material should be placed, which was in this case critical to gain credit. Also, some suggested just using a different filter with no reference to changing the filter's colour, and again could not be awarded the mark. Over 61% of students did however, give a correct reason.

06.4 Around 20% of students correctly named at least one of the variables, and a further 67% correctly named both variables. A large number of students chose to give the full headings from the table which secured them the 2 marks. Some errors commonly seen were giving the independent variable as the rate of photosynthesis rather than the time for the discs to rise, or indeed naming the two variables the wrong way around.

06.5 While expressed in many ways, just under half of students recognised that the leaf discs would float straight away if they still had air in them, and thus gained the mark.

06.6 The majority of students struggled with this question, and almost two thirds scored zero marks. A common misconception seen was students trying to link their answer to osmosis. To gain credit students needed to convey the idea that carbon dioxide could be provided or produced by the sodium hydrogen carbonate, and not simply that it contained it, which saw some students miss out on the mark. To gain two marks, students needed to develop their answer further to link the carbon dioxide provision to photosynthesis. Only around 13% of students were successful in this and gained the full 2 marks available.

06.7 Over 58% of students scored some marks in this question, and most commonly for indicating that oxygen was produced during photosynthesis**.** There were many vague ideas given for the second marking point with students simply stating 'the discs floated', without explaining a possible cause for this. Over 40% gained neither of the marks.

06.8 Most students could interpret the graph and could identify that each chlorophyll absorbed some *different* wavelengths, but they failed to explain the advantage of this in terms of the combination of chlorophyll a and b collectively being able to absorb more or many wavelengths of light. Vague responses such as 'more light absorbed' was commonly seen and did not gain credit without reference to colour or wavelength. Only around 41% of students gained this mark.

06.9 This question proved a good discriminator with only 5% of students gaining the full 4 marks, and over a third of students gaining zero marks. Students did make a good attempt at this question however, failure to use good biological terminology often prevented them from gaining either of the first two marks (or the fallback) because they failed to mention it was *chlorophyll* that was responsible for absorbing the blue/green light. Similarly, many students also failed to link the colour of light and the time for the discs to rise with a *change in rate of photosynthesis*.

The 25% of students that gained just 1 mark, most commonly gained credit for correct use of data. For this marking point students had to use both Figure 10 and Table 5, and many of the successes were seen linking a correct figure for either the peak percentage of blue light absorbed, or the minimum percentage of green light absorbed. Some ignored the instruction to refer to Figure 10 and Table 5 and only quoted values from Table 5.

4.4.1.2 Rate of photosynthesis

Answer 17 · Examiner comments

June 2023 | 8461/1H | Original Q6

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

4.4.1.2 Rate of photosynthesis

Answer 18 · Examiner comments June 2023 | 8461/2H | Original Q6

Question 6

This question was about the combined effects of respiration and photosynthesis on the carbon dioxide concentration in the air and the recovery of a rainforest community following deforestation.

06.1 Most students only considered the effects of photosynthesis in this question about changing carbon dioxide concentrations in the air in a tropical rainforest over a 24-hour period. For the first 6 hours shown in Figure 9 there was no light – hence only respiration took place and this produced carbon dioxide, hence the high levels of carbon dioxide shown on the graph. Many students understood that photosynthesis would not occur in the dark but then attributed respiration solely to animals in the forest. Between 8 am and 12 noon, the graph showed that carbon dioxide levels decreased. While most understood that the plants would be photosynthesising at this time, few realised that respiration also took place but the rate of photosynthesis exceeded that of respiration – hence a net uptake of carbon dioxide. Fewer than one-quarter of students reached even half-marks and only 1 percent scored all 4 marks.

Answer 18 · Examiner comments June 2023 | 8461/2H | Original Q6

06.2 Many students missed the concept of the time factor in answering this question which asked for an explanation why replacing rainforest with a maize crop would increase the carbon dioxide concentration in the air over one year. Using information from Figure 9 and Figure 10 should have indicated that maize removed less carbon dioxide from the air over the course of one day (not simply that the carbon dioxide concentration in the air decreased less at midday). Although many commented on the maize crop growing for just 6 months of the year, few stressed that this would mean the maize was only taking in carbon dioxide for half the year compared to the rainforest doing the same throughout the year. Only 1 in 40 students fully demonstrated their understanding of this situation.

06.3 Figure 11 showed an increase in the number of tree species with time following deforestation. The data were presented as percentages compared with adjacent control areas. About half of the students appreciated that presenting the data as percentages enabled comparisons to be made, but hardly any made the point that the initial numbers of species would have varied from one study area to another thus making a comparison of absolute numbers invalid. Mistakenly referring to the number of trees rather than to the number of tree species was quite common.

06.4 The stem to this question gave the information that the biodiversity of trees increased in the regenerating forest, but many restated this as their conclusion from the data in Figure 11. Further details from the data were required – such as the number of tree species exceeding the original number after about 50 years, or the fact that for any point in time there was great variability from one area to another, or a description of the changing pattern of recovery with time. Only 10 percent were successful here.

06.5 Many attributed the given increase in animal diversity in the regenerating rainforest to there being more food or more habitat available rather than to more variety of food types and more types of habitat.

4.4.1.2 Rate of photosynthesis

Answer 19 · Examiner comments June 2024 | 8461/1H | Original Q7

Question 7 (standard, standard/high demand and high demand)

07.1 Most students were able to access this question on factors affecting photosynthesis, with only 12% scoring zero marks. 15% of students scored full marks, with the most common mark being 3 (achieved by 23% of students). Students who ordered their answer in the order that the leaves were given in the table tended to score more highly than those who gave a general answer about all three leaves mixed together. A number of students did not answer using an absolute, stating that no light meant 'less' photosynthesis or 'less' glucose produced, which is incorrect. A significant proportion of students explained that, in the absence of light or carbon dioxide, the leaf would break down the starch already present into glucose, therefore achieving the fall back mark for marking points 4 or 5.

Occasionally, students missed out on credit for good understanding of processes by using incorrect symbols for carbon dioxide, such as CO2, Co2 or CO^2. Students should be encouraged to write out chemical names in full where possible, to avoid this from happening.

07.2 85% of students answered this question correctly.

07.3 In this question, set at high demand, 56% of students scored zero marks, 33% scored one mark, and 9% scored two marks. Some students showed an understanding of the green part of the leaf containing chloroplasts, but did not go on to link this to chlorophyll, and thus did not meet the requirements for marking point 1. Although many students came close to achieving marking point 2, most lacked the complete answer referencing light absorption linked to an effect on photosynthesis and starch formation, which was required to achieve the mark.

07.4 87% of students were able to identify a correct ion in this question, with the most common responses being magnesium and nitrate. 'Nitrogen' as an incorrect alternative to nitrate was occasionally given by some.

07.5 Only 39% of students could recall the term 'chlorosis', with 'discoloration', 'lack of colour' or 'lack of chlorophyll' being the most common incorrect responses seen.

07.6 17% of students scored the mark in this question. Whilst most understood the idea of measuring the oxygen produced in photosynthesis, the majority were not specific in referencing volume and many did not refer to time.

07.7 19% of students gave a creditworthy response to this question. Students answered in many ways, often incorrectly stating that a limiting factor is one that would stop or decrease the rate of photosynthesis when in short supply, instead of stopping the rate from increasing.

A large proportion of students repeated the words in the question, saying 'it is something that limits the rate of photosynthesis', which was not creditworthy. Despite the use of the word 'rate' in the previous question, many students did not include it in their answer.

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4.4.1.2 Rate of photosynthesis

Answer 19 · Examiner comments June 2024 | 8461/1H | Original Q7

07.8 In this question, set at high demand, less than 11% of students scored more than one mark. 27% scored one mark and 67% scored zero.

A majority of students appeared to not acknowledge the command word and tended to describe the graph, rather than explain it. Students who answered this question in parts tended to score marking point 2 and marking point 3 more regularly than those who gave a general answer. Some students began to express their ideas about temperature and carbon dioxide concentration, but were unable to gain marks due to a lack of detail. As in other question parts, some wrote the symbols for carbon dioxide incorrectly, which was only taken into account once across the entire answer.

Marking point 1 was rarely achieved, with many students describing all four lines on the graph without comparing them. For marking point 4, students often discussed one (or more) of the rates reaching a plateau but did not discuss *all* of the rates. Those that did often disqualified themselves by writing that the plateau was where light became the limiting factor.

07.9 84% of students were able to identify the inverse square law.

Answer 20 · Examiner comments

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

04.1 89% of students were able to identify the independent variable in the investigation. The most common incorrect answer was 'time taken to release 10 bubbles', which was the dependent variable. Other incorrect answers seen included the type or length of pondweed. A small minority of students had misunderstood the practical or seemed to have seen pondweed and assumed it was an investigation into the effect of light intensity and therefore gave answers such as the 'distance of the pondweed' or 'the number of bubbles produced'.

04.2 In this question students were asked to calculate the rate of photosynthesis to 3 significant figures and to include the correct units. 30% of students achieved full marks, with 39% not scoring any marks at all. Many students identified the correct value of 43 seconds from the table and those who had read the information carefully realised that this was the time for 10 bubbles to be produced and continued to correctly complete the calculation. However, a frequently seen mistake was to use the value of 20 (°C) from the table in a calculation, and this was not worthy of any credit. Some students converted their answer to bubbles per minute and as long as this was given to 3 significant figures (14.0) and the units were correct, could achieve full marks. Also seen, although rarely, was a conversion to bubbles per hour and again, this could be credited with all available marks. Most students were correctly able to round their answer to 3 significant figures. However, many students struggled to identify the correct units, with common incorrect answers including cm^3/s, O_2/s or b/s (presumably trying to abbreviate bubbles to b, which was not worthy of credit). Students should be encouraged to work out units from the calculation they have completed.

04.3 The majority of students (59%) were able to gain the first marking point and state that the rate was higher at 40 °C than at 10 °C. The converse was also accepted. Few were able to explain why this was the case, although the majority of those that did, provided a good explanation in terms of increased energy of particles and more frequent collisions, and achieved the other two marks on offer (24%). Most students, however, went on to quote data to support their statement and this did not gain credit as it did not explain why the rate was higher. There were also some students that seemed to go on to make up their own question and explain what would happen if the temperature continued to increase, describing denaturation of enzymes. Some students attempted the correct explanation, however missed key details for the marking points, for example, stating that there is 'more energy' but not identifying that the energy is of the particles or reactants, whilst some stated that the pondweed as a whole had more energy. Others knew there were more collisions but missed that these are more frequent or more successful. Of the misconceptions seen, cells having more energy and chlorophyll being an enzyme were the most common. It was not uncommon to see confused accounts about the effect of temperature on the opening of stomata and a number of students confused photosynthesis with respiration.

4.4.1.2 Rate of photosynthesis

Answer 20 · Examiner comments June 2025 | 8461/1H | Original Q4

04.4 79% of students scored full marks in this question. The full range of answers on the mark scheme were seen, with the most common being carbon dioxide and light intensity. Carbon dioxide was often given as CO_2. Students need to take care when giving the chemical formula for carbon dioxide as the 2 was occasionally seen superscript or the same size as the C and the O, which are both incorrect.
Other common incorrect answers were pH, surface area, concentration of solution or amount of oxygen. Answers affecting the rate of transpiration, e.g. humidity, were ignored and any suggestion that wind was a factor was not accepted. It was surprising to see a number of students giving temperature as an answer, despite being specifically told not to.

04.5 In this question, students were asked to give one way the method could be changed to obtain more accurate results. 18% of students were able to give a correct response to this question by identifying the equipment that could be used and how it could be used to collect the oxygen or measure its volume. Some got close to gaining the mark, however, only gave part of the answer required e.g. identifying that the volume needed to be measured but not stating which piece of equipment to use or using a measuring cylinder to collect the gas but forgetting that it needed to be inverted to do so. Another common omission was volume as 'amount' or 'how much' were too vague for the mark to be awarded. Occasionally, students did not achieve the mark due to reference to the incorrect gas (carbon dioxide), There were many others who purely gave general improvements to the practical, the most common being to carry out repeats and calculate a mean or suggesting variables that should be controlled and ensuring that no other factor was limiting. Another common suggestion was to use smaller intervals of temperature. A few even suggested a completely different investigation, changing the independent variable to the more familiar light intensity investigation and therefore changing the distance of the light. These ideas were not creditworthy.

04.6 Students were asked to describe two ways a gardener could identify a plant disease. This question discriminated well and all options on the mark scheme were seen. Only 27% of students scored full marks with 57% scoring zero. Commonly, students merely gave symptoms to look out for e.g. colour of leaves or drooping, but such answers were not creditworthy. The most common correct response was reference to a gardening manual or gardening website. A number of students gave both of these options but as they were the same marking point (involving the same idea of using a source), could only be credited once. Others were too vague to achieve this point with statements such as 'look it up', or Google it', without giving an idea of where or what was to be looked up. MP2 was also frequently seen, with students suggesting a sample of the plant could be taken to a lab for testing. MP3 was less frequently seen and often when students attempted this marking point, they just stated that a 'test kit' should be used and missed the idea of the kit containing monoclonal antibodies.

04.7 80% of students were able to identify rose black spot as the disease in this question. Some added the name of the pathogen to the end of their answer, which was still creditworthy, however, an incorrect pathogen such as a virus, was incorrect. Some students omitted the words 'black' or 'spot' from their answer and therefore did not gain the mark, but answers that omitted 'rose' were still considered creditworthy. The most common incorrect answer was Tobacco Mosaic Virus / TMV.

4.4.1.2 Rate of photosynthesis

Answer 20 · Examiner comments June 2025 | 8461/1H | Original Q4

04.8 59% of students were able to gain full credit in this question by explaining why the plant developed yellow leaves. All options on the mark scheme were seen and the majority of students were able to gain a mark by identifying a shortage of magnesium ions and / or less chlorophyll. Simply stating that the plant has chlorosis was not sufficient for the mark; this needed to be linked to a shortage of one of the ions or a lack of light. Other students confused chloroplasts for chlorophyll or stated that chlorophyll was affected, but did not say how. It was not uncommon to see the idea of chlorophyll 'fading' or 'discolouring', neither of which was creditworthy. Those that started down the second route on the mark scheme often linked this to less chlorophyll, but this was insufficient – instead, students needed to state that the chlorophyll was being broken down. Another common incorrect answer was reference to TMV.