AQA GCSE Biology | 8461

SPECIFICATION POINT 4.4.1.2

Rate of photosynthesis

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**19**
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.

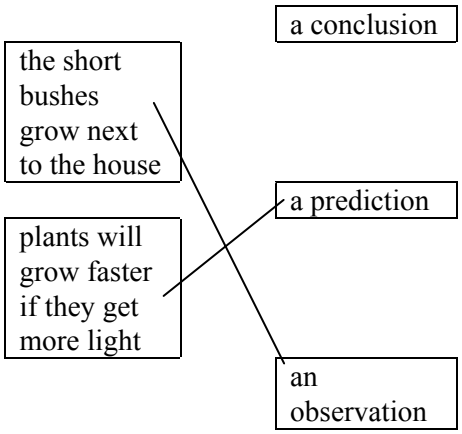
Name: _____ **Date:** _____

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 January 2008 | BLY2F | Original Q4 | Legacy

Question 4

	answers	extra information	mark
(a)(i)		both correct = **2** marks one correct = **1** mark extra line from a statement cancels the mark	2
(a)(ii)	1st space: carbon dioxide 2nd space: glucose / sugar / starch / carbohydrate	allow CO_2 (ignore superscript) do **not** allow CO alone	1 1
(b)(i)	any **one** from: • move lamp or change distance between lamp and plant • change wattage / power of (light) bulb • change voltage / power supply to the (light) bulb • change the number of lamps • put translucent material between lamp and plant	 ignore measure the distance do **not** accept just "change bulb" accept examples, eg tracing paper / filters do **not** accept coloured filters	1

continued …

4.4.1.2 Rate of photosynthesis

BLY2F

Question 4 continued …

	answers	extra information	mark
(b)(ii)	rises levels off	ignore numbers	1 1
(b)(iii)	idea that it levels off **or** does not increase at all light intensities **or** it only increases to a certain amount	answers should relate to photosynthesis and **not** to bubbling	1
total			8

4.4.1.2 Rate of photosynthesis

Answer 01 · Mark scheme

January 2008 | BLY2F | Original Q4 | Legacy

BLY2F

4.4.1.2 Rate of photosynthesis

Answer 02 · Mark scheme June 2009 | BLY2F | Original Q7 | Legacy

Question 7

question	answers	extra information	mark
7(a)(i)		answers must be in this order	1
	water / H_2O	allow hydrogen oxide	1
	oxygen / O_2 / O	allow upper and lower case symbols and superscripts	
7(a)(ii)	respiration in the plant	allow clear indication of correct response	1
7(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
7(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
7(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 | BLY2F | Original Q7 | Legacy

BLY2F

4.4.1.2 Rate of photosynthesis

Answer 03 · Mark scheme

June 2019 | BLY2F | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)	the starch is stored for later use.		1
6(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
6(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
6(c)(i)	temperature	allow heat / °C / cold	1
6(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 03 · Mark scheme

June 2010 | BLY2F | Original Q6 | Legacy

BLY2F

4.4.1.2 Rate of photosynthesis

Answer 04 · Mark scheme

January 2011 | BLY2F | Original Q7 | Legacy

Question 7

question	answers	extra information	mark
7(a)(i)	colour of light / bulb / lamp	allow wavelength for colour allow bulb alone do **not** accept light / colour unqualified	1
7(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
7(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
7(b)(i)	green		1

Question 7 continues on the next page

4.4.1.2 Rate of photosynthesis

BLY2F

Question 7 continued

question	answers	extra information	mark
7(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 04 · Mark scheme

January 2011 | BLY2F | Original Q7 | Legacy

BLY2F

4.4.1.2 Rate of photosynthesis

Answer 05 · Mark scheme

June 2012 | BL2FP | Original Q6 | Legacy

Question 6

question	answers	extra information	mark
6(a)	(LHS) water / H_2O	allow H2O do **not** accept H^2O	1
	(RHS) glucose / sugar / $C_6H_{12}O_6$	allow starch / carbohydrate allow C6H12O6 do **not** accept $C^6H^{12}O^6$	1
6(b)(i)	1 arbitrary unit	extra box ticked – cancel	1
6(b)(ii)	210		1
6(b)(iii)	carbon dioxide / CO_2 / CO2 **or** temperature / heat / warmth	do **not** accept CO^2 ignore mineral ions ignore water	1
Total			**5**

4.4.1.2 Rate of photosynthesis

Answer 05 · Mark scheme

June 2012 | BL2FP | Original Q6 | Legacy

BL2FP

4.4.1.2 Rate of photosynthesis

Answer 06 · Mark scheme

June 2012 | BL2FP | Original Q8 | Legacy

Question 8

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

8(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 06 · Mark scheme

June 2012 | BL2FP | Original Q8 | Legacy

BL2FP

4.4.1.2 Rate of photosynthesis

Answer 07 · Mark scheme

January 2013 | BL2FP | Original Q7 | Legacy

Question 7

question	Answers	extra information	mark
7(a)	any **one** from: • add a water bath • heat screen • use LED • low energy bulb / described	ignore 'check temperature'	1
7(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
7(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 7 continues on the next page . . .

BL2FP

Question 7 continued . . .

<table>
<tr><th>question</th><th colspan="4">Answers</th><th>extra information</th><th>mark</th></tr>
<tr><td rowspan="4">7(c)</td><td colspan="4">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></td><td>6</td></tr>
<tr><td>0 marks</td><td colspan="2">Level 1 (1-2 marks)</td><td>Level 2 (3-4 marks)</td><td>Level 3 (5-6 marks)</td><td></td></tr>
<tr><td>No relevant content.</td><td colspan="2">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><td></td></tr>
<tr><td colspan="5">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><td></td></tr>
<tr><td>Total</td><td colspan="3"></td><td></td><td>9</td></tr>
</table>

4.4.1.2 Rate of photosynthesis

Answer 07 · Mark scheme January 2013 | BL2FP | Original Q7 | Legacy

BL2FP

Answer 08 · Mark scheme June 2014 | BL2FP | Original Q6 | Legacy

6(a)	chlorophyll is needed for photosynthesis light is needed for photosynthesis		1 1	AO3 2.3.1b, e
6(b)	increases levels off / reaches a maximum / remains constant / stays the same / plateaus goes up to / reaches a maximum / levels off at (a rate of) 200 (arbitrary units) **or** levels off at 225 – 240 (light units)	 do **not** allow stops / stationary / peaks allow stops increasing ignore references to other numerical values	1 1 1	AO2 2.3.1c, d
6(c)(i)	higher light intensity does not increase rate of photosynthesis	accept the graph stays level (above this value) allow stops increasing allow the rate of photosynthesis stay the same (above this value)	1	AO3 2.3.1c, d
6(c)(ii)	any **two** from: • carbon dioxide (concentration) • temperature / heat • (amount of) chlorophyll / chloroplasts	 allow water allow ions / nutrients ignore ref to surface area of the leaf	2	AO1 2.3.1c, d
Total			**8**	

4.4.1.2 Rate of photosynthesis

Answer 08 · Mark scheme

June 2014 | BL2FP | Original Q6 | Legacy

Question	Answers	Extra information	Mark	AO / spec ref.

4.4.1.2 Rate of photosynthesis

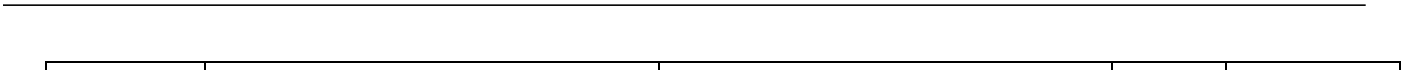
Answer 09 · Mark scheme June 2015 | BL2FP | Original Q4 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4(a)(i)	LHS = water RHS = oxygen	accept H_2O do **not** accept H^2O / H2O accept O_2 do **not** accept O / O^2 / O2	1 1	AO1 2.3.1a,b
4(a)(ii)	light / sunlight	ignore solar / sun / sunshine do **not** allow thermal / heat	1	AO1 2.3.1a,b
4(a)(iii)	chloroplasts	allow chlorophyll	1	AO1 2.3.1b
4(b)(i)	20		1	AO2 2.3
4(b)(ii)	any **one** from: • light (intensity) • temperature		1	AO2 2.3, 2.3.1c,d
4(c)(i)	To increase the rate of growth of the tomato plants		1	AO2 2.3, 2.3.1c,d
4(c)(ii)	Because it would cost more money than using 0.08% Because it would not increase the rate of photosynthesis of the tomato plants any further		1 1	AO2 2.3, 2.3.1c,d
Total			**9**	

4.4.1.2 Rate of photosynthesis

Answer 09 · Mark scheme

June 2015 | BL2FP | Original Q4 | Legacy



4.4.1.2 Rate of photosynthesis

Answer 10 · Mark scheme June 2015 | BL2FP | Original Q8 | Legacy

8			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

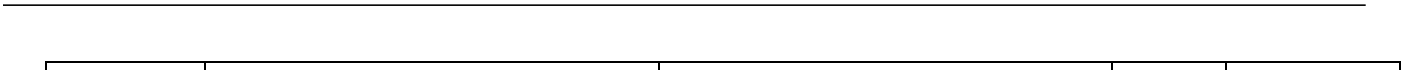
allow attempt to overcome other variables – eg soil water / soil pH / temperature

Total		**6**

4.4.1.2 Rate of photosynthesis

Answer 10 · Mark scheme

June 2015 | BL2FP | Original Q8 | Legacy



4.4.1.2 Rate of photosynthesis

Answer 11 · Mark scheme June 2016 | BL2FP | Original Q8 | Legacy

Question	Answers	Extra information	Mark	AO / Spec. Ref.
8			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 and measuring volume in a syringe
- measuring **rate of photosynthesis** by counting bubbles for set period of time
- repetitions

extra information

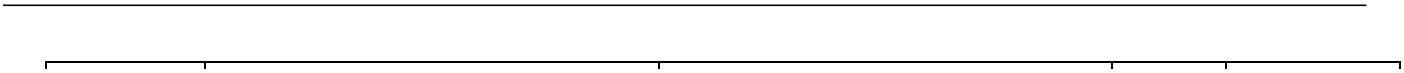
allow information in the form of a diagram

Total		6

4.4.1.2 Rate of photosynthesis

Answer 11 · Mark scheme

June 2016 | BL2FP | Original Q8 | Legacy



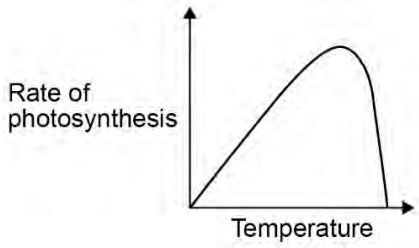
4.4.1.2 Rate of photosynthesis

Answer 12 · Mark scheme June 2019 | 8461/1F | Original Q9

09.1	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
09.2	power output of bulb		1	4.4.1.2 AO2
09.3	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
09.4	3.3 (cm^3/hour)		1	4.4.1.2 AO2

4.4.1.2 Rate of photosynthesis

Answer 12 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5	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 **09.4**	2	
	correct curved line of best fit	ignore line extended beyond 60 / 250 (W) ignore line joined point to point with straight lines	1	
09.6	correct answer from their line drawn on **Figure 15**	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
09.7			1	4.4.1.2 AO2
Total			**12**	

4.4.1.2 Rate of photosynthesis

Answer 13 · Mark scheme

November 2020 | 8461/1F | Original Q7

The full source mark scheme begins on page 44. Follow original question 7 in that document.

4.4.1.2 Rate of photosynthesis

Answer 14 · Mark scheme November 2020 | 8461/2F | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	put all the dishes the same distance from the radiator use equal numbers of seedlings in each dish		1 1	AO3 4.5.4.1 RPA8
02.2	the height of the seedlings		1	AO1 4.5.4.1 RPA8
02.3	any **two** from: • light • water • mineral(s) / ions / salts	allow nitrate / magnesium / nitrogen / nutrients allow space ignore food ignore carbon dioxide / oxygen ignore heat	2	AO2 4.7.1.2
02.4	side **P** has grown less than side **Q**		1	AO3 4.5.4.1 RPA8
02.5	phototropism		1	AO1 4.5.4.1 RPA8
02.6	auxin		1	AO1 4.5.4.1
Total			**8**	

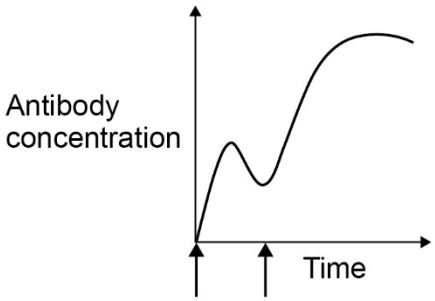
4.4.1.2 Rate of photosynthesis

Answer 14 · Mark scheme

November 2020 | 8461/2F | Original Q2

4.4.1.2 Rate of photosynthesis

Answer 15 · Mark scheme November 2021 | 8461/1F | Original Q2

02.1	pathogens		1	AO1 4.3.1.1
02.2	viruses reproduce inside cells, damaging them		1	AO1 4.3.1.1
02.3	any **one** from: • they do not have a cell membrane • they do not have cytoplasm • they do not have a nucleus • they do not have mitochondria (like most eukaryotic cells) • they do not have ribosomes	do **not** accept they do not have a cell wall do **not** accept they do not have chloroplasts / chlorophyll ignore they are not living / alive ignore they can only replicate inside cells ignore virus has a protein coat	1	AO2 4.1.1.2
02.4	a weakened form of a virus		1	AO1 4.3.1.7
02.5			1	AO2 4.3.1.7
02.6	leaf		1	AO1 4.3.1.2

4.4.1.2 Rate of photosynthesis

Answer 15 · Mark scheme

02.7	y-axis labelled rate of photosynthesis in arbitrary units correct scale all bars plotted correctly all bars correctly labelled	 allow a tolerance of ± ½ small square allow 2 correct bars for **1** mark allow bars touching allow any width of bars ignore letters	1 1 2 1	AO2 4.4.1.1
02.8	as the level of infection (with TMV) increases, (the rate of) photosynthesis decreases	allow as TMV increases, photosynthesis decreases allow (the rate of) photosynthesis decreases as the level of infection (with TMV) increases allow as infection gets worse, photosynthesis decreases allow TMV reduces photosynthesis	1	AO3 4.4.1.1
02.9	less chlorophyll (so) less glucose / starch / protein made	allow fewer chloroplasts allow less light absorbed ignore less photosynthesis	1 1	AO2 4.4.1.1 4.4.1.3 4.3.1.2
Total			**14**	

4.4.1.2 Rate of photosynthesis

Answer 15 · Mark scheme

November 2021 | 8461/1F | Original Q2

Question	Answers	Extra information	Mark	AO / Spec. Ref.

4.4.1.2 Rate of photosynthesis

Answer 16 · Mark scheme

June 2022 | 8461/1F | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	any **two** from: • temperature • size of tomato plants **or** size / number of leaves • light • (volume of) water • (amount / type of) fertiliser / minerals / ions / nutrients (given to plants) • time before rate readings are taken	allow age of plant allow (amount of) water allow (type of) compost / soil allow named example of mineral ion such as nitrate / magnesium ignore time unqualified ignore type of tomato plant ignore type of greenhouse	2	AO3 4.4.1.2 RPA6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	from 0.02% to 0.04%		1	AO3 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	repeat each reading three times and calculate a mean		1	AO3 4.4.1.2 RPA6

4.4.1.2 Rate of photosynthesis

Answer 16 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	(the rate of photosynthesis) increases (because) carbon dioxide is needed for photosynthesis	ignore values allow **2** marks for (there is) more carbon dioxide for (more) photosynthesis	1 1	AO2 4.4.1.1 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	any **two** from: • it would not increase the rate (of photosynthesis) • it would not increase the growth of tomatoes • it would cost more	 allow it would not change the rate (of photosynthesis) allow photosynthesis would not increase allow idea of profit will not increase allow reference to avoiding global warming	2	AO3 4.4.1.2

Total Question 3		**8**

4.4.1.2 Rate of photosynthesis

Answer 17 · Mark scheme

June 2023 | 8461/1F | Original Q3

Question 3

Question	Answers	Extra information	Mark	AO / Spec Ref.
03.1	*(lhs)* carbon dioxide water *(rhs)* glucose	allow word(s) take precedence over formulae } in either order	 1 1 1	AO1 4.4.1.1

Question	Answers	Extra information	Mark	AO / Spec Ref.
03.2	(used in aerobic) respiration to release / transfer energy	do **not** accept anaerobic allow for energy allow (respiration) by mitochondria do **not** accept energy created / made / produced	1 1	AO1 4.4.1.2 4.4.2.1

4.4.1.2 Rate of photosynthesis

Answer 17 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec Ref.
03.3	any **one** pair from: • bulb / lamp is hot (so) may burn you / skin • glassware is breakable (1) (so) may cut skin (1) • electricity in close proximity to water (1) (so) may get electric shock (1) • scissors / scalpel (to cut pondweed) are sharp (1) may cut skin (1)	mark in pairs allow named example of electrical item in close proximity to water	1 1	AO2 4.4.1.2 RPA6

Question	Answers	Extra information	Mark	AO / Spec Ref.
03.4	(use a) water bath	allow put beaker into (another) beaker of water allow other correct methods eg heat shield allow use an LED	1	AO2 4.4.1.2 RPA6

4.4.1.2 Rate of photosynthesis

Answer 17 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec Ref.
03.5	(change in) temperature affects / changes (the rate of) photosynthesis	allow temperature is a limiting factor (of photosynthesis) allow temperature affects enzyme (activity) allow temperature affects rate of reaction	1	AO2
	(so) will affect / change the number of bubbles (produced)	allow (so) will affect results allow (so) will affect validity ignore to make it fair ignore so the results will be the same	1	AO3 4.4.1.2 RPA6

Question	Answers	Extra information	Mark	AO / Spec Ref.
03.6	blue		1	AO3 4.4.1.2 RPA6

Question	Answers	Extra information	Mark	AO / Spec Ref.
03.7	bar graph		1	AO3 4.4.1.2 RPA6

Question	Answers	Extra information	Mark	AO / Spec Ref.
03.8	any **one** from: • measuring cylinder • (gas) syringe • burette		1	AO3 4.4.1.2 RPA6

4.4.1.2 Rate of photosynthesis

Answer 17 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec Ref.
03.9	as light (intensity) increases, rate / photosynthesis increases (rate / photosynthesis increases) at the same rate as light (intensity)	allow positive correlation allow rate / photosynthesis increases linearly / evenly allow description of shape of line eg straight / linear allow rate is (directly) proportional to light (intensity) for **2** marks	1 1	AO3 4.4.1.2

Total Question 3	**15**

4.4.1.2 Rate of photosynthesis

Answer 18 · Mark scheme

June 2025 | 8461/1F | Original Q2

Question 2

Question	Answers	Extra information	Mark	AO / Spec Ref.
02.1	temperature of pondweed		1	AO1 4.4.1.2 RPA6

Question	Answers	Extra information	Mark	AO / Spec Ref.
02.2	oxygen chlorophyll	in this order only	1 1	AO1 4.4.1.1 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec Ref.
02.3	 (time) decreases then (time) increases	ignore use of data allow rate / speed increases allow then rate / speed decreases	 1 1	AO3 4.4.1.2 RPA6

Question	Answers	Extra information	Mark	AO / Spec Ref.
02.4	$\frac{10}{33}$ 0.3030… 0.3	 do **not** accept 0.30 allow correct rounding to 1 dp from a calculation using an incorrect value for time from **Table 2**	1 1 1	AO2 4.4.1.2

Question	Answers	Extra information	Mark	AO / Spec Ref.
02.5	40 °C		1	AO3 4.4.1.2 RPA6

Question	Answers	Extra information	Mark	AO / Spec Ref.
02.6	more than 77 seconds		1	AO3 4.4.1.2

4.4.1.2 Rate of photosynthesis

Answer 18 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec Ref.
02.7	concentration of carbon dioxide light intensity		1 1	AO1 4.4.1.2 RPA6

Total Question 2	**12**

4.4.1.2 Rate of photosynthesis

Answer 19 · Mark scheme

June 2025 | 8461/2F | Original Q6

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	sunlight		1	AO1 4.7.4.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	worm **or** snail		1	AO3 4.7.4.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3			1	AO3 4.7.4.2 4.7.4.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	1%		1	AO2 4.7.4.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	faeces movement		1 1	AO1 4.7.4.3 4.7.5.2

4.4.1.2 Rate of photosynthesis

Answer 19 · Mark scheme

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.6	(fish) 3 (snails) 12 (worms) 23	all correct = **2** marks 1 or 2 correct = **1** mark	2	AO2 4.7.2.1

Total Question 6	**8**

4.4.1.2 Rate of photosynthesis

AQA

GCSE
BIOLOGY
8461/1F

Paper 1 Foundation Tier

Mark scheme

June 2020

Version: 1.0 Final Mark Scheme

jun2084611F/MS

4.4.1.2 Rate of photosynthesis

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.

Further copies of this mark scheme are available from aqa.org.uk

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4.4.1.2 Rate of photosynthesis

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.

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.

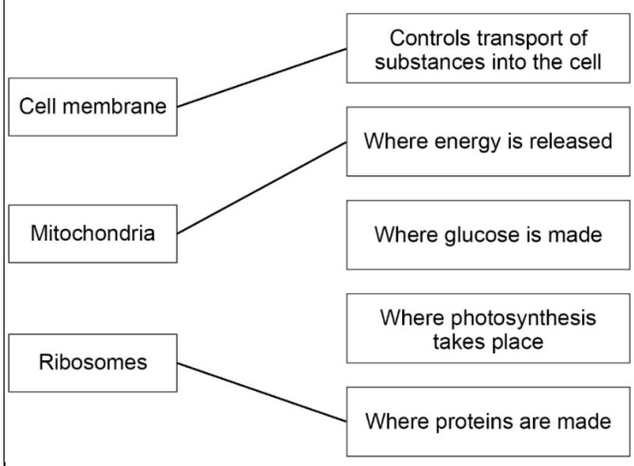
You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

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	bacterium		1	AO2 4.1.1.1
01.2	to strengthen the cell		1	AO1 4.1.1.1 4.1.1.2
01.3	chloroplast		1	AO2 4.1.1.2 4.2.3.1
01.4	**Structure** **Function**  additional line from a box on the left negates the mark for that box		3	AO1 4.1.1.2 4.1.3.1
01.5	adjust the focus knob		1	AO3 4.1.1.2 RPA1
01.6	(A =) 15 (mm) (B =) 60 (mm)	allow a tolerance of ± 1mm	1 1	AO2 4.1.1.2 RPA 1
01.7	$\frac{60}{15} = 4(.0)$	allow ecf from question **01.6**	1	AO2 4.1.1.2 RPA 1

4.4.1.2 Rate of photosynthesis

01.8	$\frac{40}{0.1}$ 400	 do **not** accept if a unit is given	1 1	AO2 4.1.1.5 RPA 1
Total			**12**	

4.4.1.2 Rate of photosynthesis

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	mitosis		1	AO1 4.1.2.2
02.2	all lines correct = **2** marks 1 or 2 lines correct = **1** mark **Stage of cell cycle** / **What happens during that stage** Stage 1 → The cell grows and the chromosomes replicate Stage 2 → One set of chromosomes is pulled to each end of the cell Stage 3 → The cytoplasm and cell membrane divide to form two new cells additional line from a box on the left negates the credit for that box		2	AO1 4.1.2.2
02.3	$\frac{7}{10} \times 100$ 70(%)	allow $\frac{252}{300} \times 100$ allow answer calculated from angle in range 250° to 254° if no other mark awarded, allow 0.7 for **1** mark	1 1	AO2 4.1.2.2
02.4	3		1	AO2 4.1.2.2
02.5	DNA	allow deoxyribonucleic acid	1	AO1 4.1.2.1 4.1.2.2
02.6	a gene		1	AO1 4.1.2.1

4.4.1.2 Rate of photosynthesis

02.7	(bone marrow) cells differentiate into many / other types of (named) cell (so) will cure diseases where new cells are needed **or** will cure diseases where cells are damaged	allow (bone marrow) cells can become many / other types of (named) cell allow (so) will cure anaemia / leukaemia **or** blood cancer **or** blood disorders allow (so) will cure paralysis / diabetes	1 1	AO1 AO2 4.1.2.3
Total			**10**	

4.4.1.2 Rate of photosynthesis

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	any **one** from: • bacteria • fungi • protists	allow singular allow names of pathogens e.g. Salmonella ignore virus / germ	1	AO1 4.3.1.1 4.3.1.3 4.3.1.5
03.2	hydrochloric acid is produced by the stomach the skin is a barrier covering the whole body		1 1	AO1 4.2.2.1 4.3.1.6
03.3	white blood cells engulf the microorganisms.		1	AO1 4.2.2.3 4.3.1.6
03.4	weakened fast	in this order only	1 1	AO1 4.3.1.7
03.5	by coughs / sneezes	allow 'by droplets in the air' do **not** accept other means of transmission e.g. touch	1	AO1 4.3.1.1 4.3.1.2
03.6	(from day) 10 (to day) 18	allow (from day) 18 (to day) 10	1	AO2 4.3.1.2
03.7	14 (days)	allow in the range 13 to 15 (days)	1	AO3 4.3.1.2
03.8	any **one** from: • they had been vaccinated • they already had antibodies • they were immune • they had had it before • they did not get any / enough virus from infected child • they did not play (much) with the infected child	 ignore they were resistant ignore they wore a mask unqualified	1	AO3 4.3.1.2 4.3.1.7

4.4.1.2 Rate of photosynthesis

03.9	antibiotics do not kill viruses	allow antibiotics do not work on viruses allow antibiotics only kill bacteria	1	AO3 4.3.1.8
Total			**11**	

4.4.1.2 Rate of photosynthesis

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	increased (at first) until 4 minutes **or** 50 breaths per minute (then) stayed constant (from 4 minutes **or** at 50 breaths per minute)		1 1 1	AO2 4.4.2.2
04.2	175 (beats per minute)		1	AO2 4.4.2.2
04.3	140 (beats per minute)		1	AO2 4.4.2.2
04.4	because his rate is lower than the maximum safe rate	allow ecf for incorrect values in question **04.2** and question **04.3**	1	AO3 4.2.2.2 4.4.2.2

4.4.1.2 Rate of photosynthesis

04.5	**Level 3:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO3
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	AO2
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	AO2
	No relevant content	0	

	Indicative content
	
	• heart rate increased
	  ○ to increase blood flowing to muscles / lungs
	  ○ to provide more oxygen (to muscles)
	  ○ to provide more glucose (to muscles)
	  ○ to remove carbon dioxide more quickly (from the muscles / blood)
	  ○ to remove lactic acid more quickly (from the muscles)
	
	• breathing rate increased
	  ○ supplies more oxygen / air to lungs
	  ○ so more oxygen to blood
	  ○ more carbon dioxide removed
	
	• more oxygen to muscles
	  ○ needed for (increased) respiration
	  ○ to release / provide energy
	  ○ for muscle contraction
	
	• anaerobic respiration occurs
	  ○ due to lack of oxygen
	  ○ which causes a build-up of lactic acid
	  ○ oxygen debt
	  ○ muscle fatigue / pain
	
	To reach **Level 3**, there must be reference to heart rate, breathing rate and respiration
			4.2.2.2
			4.2.2.3
			4.4.2.1
			4.4.2.3
			4.4.2.2

Total			**12**

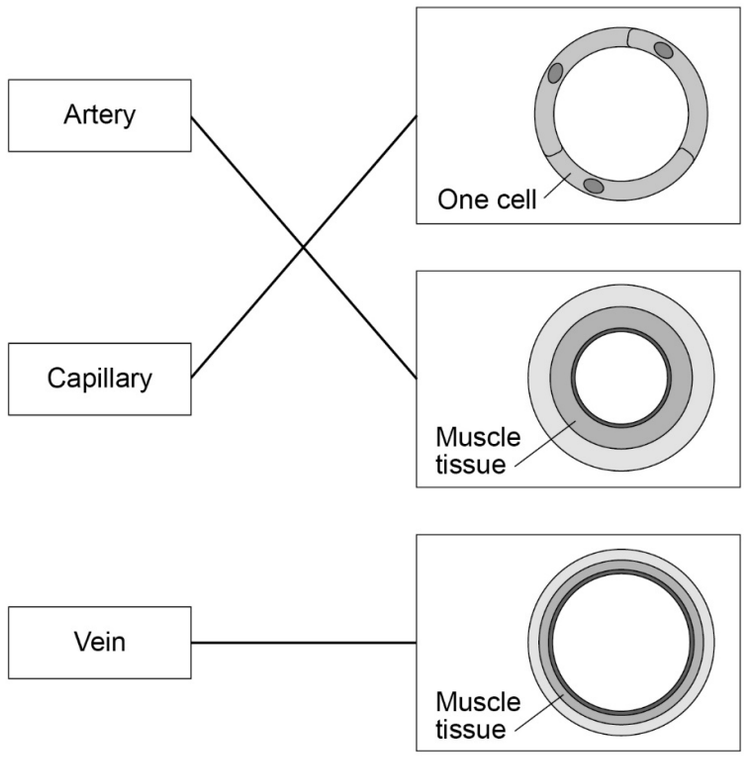
4.4.1.2 Rate of photosynthesis

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	will stop animals / herbivores eating it	allow it will not be eaten	1	AO3 4.3.3.2
05.2	chemical		1	AO1 4.3.3.2
05.3	thorns / spikes / spines / prickles (to stop animals / herbivores eating it)		1	AO3 4.3.3.2
05.4	for respiration to store as starch		1 1	AO1 4.4.1.3 4.4.2.1
05.5	add Benedict's (solution / reagent to the liquid) boil / heat (if glucose is present the blue) colour changes to yellow / green / orange / brown / (brick)red	 allow any temperature of 65 °C or above 	1 1 1	AO1 4.2.2.1 RPA 4
05.6	(nitrate ions are needed) to make proteins / amino acids which are needed for growth / enzymes / new cells	allow to make chlorophyll / DNA / ATP / nucleic acid allow correct process for named molecule in mp1	1 1	AO1 AO2 4.1.3.3 4.4.1.3 4.4.2.3
05.7	in / on the (soil) water	allow through air (spaces) in the soil	1	AO3 4.3.1.1 4.3.1.4
05.8	dosage toxicity		1 1	AO1 4.3.1.9

4.4.1.2 Rate of photosynthesis

05.9	placebos		1	AO1 4.3.1.9
Total			**14**	

4.4.1.2 Rate of photosynthesis

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	all lines correct = **2** marks 1 **or** 2 lines correct = **1** mark **Type of blood vessel** / **Structure of blood vessel**  additional line from a box on the left negates the credit for that box		2	AO2 4.2.2.2

4.4.1.2 Rate of photosynthesis

06.2	any **one** from: • thick(er) (muscle) walls / tissue (1) to push blood (all) around the body (1) **or** • thick(er) elastic walls / tissue (1) to maintain / withstand high (blood) pressure **or** to retain / regain shape (1) **or** • narrow lumen (1) to maintain high (blood) pressure (1)	allow to withstand high (blood) pressure do **not** accept to pump blood (all) around the body	2	AO1 4.2.2.2
06.3	(A) – white (blood) cell(s) (B) – platelet(s)	allow any named white (blood) cell(s)	1 1	AO2 4.2.2.3
06.4	(no nucleus) more space for haemoglobin / oxygen (has haemoglobin) to bind / carry oxygen	allow to carry more oxygen ignore carries carbon dioxide	1 1	AO3 4.1.1.2 4.1.1.3 4.2.2.3
06.5	plasma		1	AO1 4.2.2.3
06.6	platelets		1	AO3 4.2.2.3

4.4.1.2 Rate of photosynthesis

06.7	any **one** from: • (continued) bleeding • (more) bruising	allow described allow blood does not clot (at cuts) allow ecf from answer to question **06.6**	1	AO3 4.2.2.3
Total			**11**	

4.4.1.2 Rate of photosynthesis

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	*before arrow* carbon dioxide **and** water *after arrow* glucose	allow correct chemical symbols ignore any attempt at balancing equation ignore light / chlorophyll either order ignore sugar / carbohydrate do **not** accept starch	 1 1	AO1 4.4.1.1
07.2	light (light) is captured / trapped / absorbed by chlorophyll / chloroplasts	ignore description of subsequent parts of the photosynthesis reaction allow sunlight ignore sun allow (light) is used by chlorophyll / chloroplasts	 1 1	AO1 4.1.1.2 4.4.1.1
07.3	$\frac{(18.5 + 19.3 + 19.5)}{3}$ **or** $\frac{57.3}{3}$ 19.1 (cm^3/hour)	 allow an answer correctly calculated using only two correct values	1 1	AO2 4.4.1.2 RPA 6
07.4	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

07.5	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
07.6	did not use it in calculation (of mean)		1	AO3 4.4.1.2 RPA 6
07.7	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
07.8	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

07.9	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.
08.1	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	
08.2	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

08.3	**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

08.4	Osmosis	allow diffusion	1	AO1 4.1.3.1 4.2.3.2 4.1.3.2
08.5	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

Answer 13 · Examiner comments November 2020 | 8461/1F | Original Q7

Question 7 (standard demand)

The equation for photosynthesis had been generally well learnt, with two-thirds of students scoring at least one mark. **07.2** was not answered well, with the reference to 'energy' leading some students to write confused accounts about respiration. Nearly two-thirds of students were able to identify the anomalous result in **07.4**. In **07.5**, reference to 'human error' on its own was insufficient.

The concept of denaturation in **07.8** was not acknowledged by most students, as they were unable to make the link between photosynthesis and enzymes. Students are advised to read and follow all of the instructions given when asked to draw a graph, as in **07.9**, 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 14 · Examiner comments November 2020 | 8461/2F | Original Q2

Question 2 (low demand)

This question was about phototropism. In **02.2**, fewer than half of the students correctly identified the dependent variable. Of the majority giving an incorrect response, the most common, by far, was the temperature of the room. For **02.3** most students gave at least one correct response, usually identifying light or water as factors being competed for; although many students gave both of these. The other most commonly suggested allowable response was 'space'. In **02.4**, a large proportion of students gave the incorrect answer, that side P (facing the light) grows more than side Q – an obvious misconception about the effect of more or faster growth on one side of the shoot. Given the clear bend in the shoot, a large number suggested that the two sides had grown equally.

4.4.1.2 Rate of photosynthesis

Answer 16 · Examiner comments

June 2022 | 8461/1F | Original Q3

Question 3 (Low and standard demand)

03.1 When faced with the concept of understanding photosynthesis in a context other than that of the Required Practical Activity, some students faltered. Most students were able to name one control variable in the investigation, with the most common response being light (intensity). Many students gave 'type of tomato plant', despite the stem of the question indicating that the investigation was only carried out on one type of plant. A number of students confused the independent variable and the control variable, stating the percentage of carbon dioxide would be a control variable.

03.2 Over 80% of students were able to identify where the greatest change in rate occurred.

03.3 Over 85% of students understood that repeating readings would improve the validity of the results.

03.4 Very few students appeared to understand that the command word 'explain' required them to do just that. A number of students gave the values for the rate of photosynthesis at 0.00% and 0.08% carbon dioxide, but did not get credit for their answer as they did not go on to describe the increase. Very few students made the link between the increased rate and carbon dioxide being needed for the reaction, with less than 10% of students achieving both marks. It is worth noting here that a significant proportion of students continue to give the formula molecules such as carbon dioxide; if they do, the formula must be correct. CO2, CO^2 and Co2 are all incorrect.

03.5 Many students were able to articulate the idea that the rate of photosynthesis would not increase beyond 0.08% carbon dioxide, but making further links as to why this would influence the famer's decision were rarely seen, with less than 10% of students achieving both mark points. Occasionally, reference to global warming was seen, but often this was not linked to the increased concentration of carbon dioxide. This question was another example of where poor articulation and lack of explanatory detail cost some students marks; for example, phrases such as 'he would get the same result' was not enough to gain the mark.

4.4.1.2 Rate of photosynthesis

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Question 3 (Low and standard demand)

03.1 It was pleasing to see that over two thirds of students could demonstrate sound recall of the equation for photosynthesis and gained all three marks. Glucose was sometimes incorrectly given as a reactant, and protein or fat occasionally, as a product.

03.2 This question proved a challenge for many students, and many attempted to explain how the oxygen might enter or be carried by red blood cells, rather than how it is used by cells. Answers such as this gained no credit, and almost 60% of student gained zero marks. While some correctly mentioned 'respiration', only 10% of students went on to discuss the resultant release of energy for the second mark. Incorrect responses which suggested that energy could be 'made' were less obvious than in previous years. Several answers referred to respiration occurring in mitochondria and this was given credit for two marks.

03.3 It was very pleasing to note that students are acutely aware of health and safety issues in practical work. The hazards and risks in this question were in the context of an investigation into light and photosynthesis. Credit could not, therefore, be given to the idea of harmful liquids splashing into eyes as only water was used. Neither were marks awarded for the idea that the light in the experiment could damage eyesight. Almost 36% of responses seen gained both marking points, with reference to possible burns from hot bulbs being the most common. Those who mentioned broken glassware often failed to gain two marks by failing to go on to suggest that this might lead to cuts of the skin. Other weak responses just mentioned possible electrocution without giving a clear linked hazard.

03.4 This question proved a good discriminator, with only around 22% of students gaining the mark. Many vague responses were seen, for example, keeping the apparatus in the same room each time the experiment was carried out, and others believed that the beaker of water should be heated with a Bunsen burner. Some students said that they would keep a check on the temperature by using a thermometer but failed to give any idea of what should be done if this temperature changed. Good answers referred to use of a water bath or an LED bulb. Credit was given to the idea of insulating the beaker provided that the material used, if mentioned, would still allow light through.

03.5 Students found it hard to express their ideas when answering this question, and consequently just over half of students failed to gain either available marking point. Responses that did not gain credit included – 'to make the experiment fair', 'to make sure everything was accurate', 'to keep the results the same all the time', 'because the pondweed could die if it got too hot'. One mark was given for acknowledging that temperature affects photosynthesis in some way, and where students gained only 1 mark, it was usually for this idea. The second part of the explanation, however, that this would then affect the actual results obtained was less frequently seen.

03.6 Almost all students that attempted this question, correctly chose the colour blue.

03.7 A little over two thirds of students were successful in identifying a bar graph, as being the best way to display the results.

03.8 The majority of students failed to name a piece of apparatus used to measure the volume of oxygen produced. Around 30% of students gained the mark, and indeed the use of a measuring cylinder was the most common response.

03.9 Over two thirds of students gained the first mark here by correctly stating that as light intensity increased, the rate of photosynthesis did the same. A few failed to gain credit as they gave

4.4.1.2 Rate of photosynthesis

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the relationship the wrong way round, thereby implying that an increase in photosynthesis caused the increase in light. Only 10% of students gained the second mark for the increase of both being at the same rate as each other. A few incorrectly suggested that the rate was 'constant'.

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Question 2 (low demand)

02.1 Two thirds of students were able to correctly identify the independent variable.

02.2 77% of students scored full marks in this question. The most frequently seen errors were nitrogen for MP1 and cellulose for MP2.

02.3 A third of students scored 2 marks, a third 1 mark and a third zero marks in this question. Many students did not realise that the data recorded was the time taken to release 10 bubbles, rather than the number of bubbles released in a set time. A significant proportion of students, therefore, struggled to articulate their ideas, with a lot of confusion over time and speed seen. Answers given, therefore, incorrectly described an increase followed by a decrease. Many gained MP1 but fewer went on to match MP2. They referred, instead, to the overall decrease up to 60 °C rather than giving consideration to the 'describe' command word which encompassed the whole span of the investigation. Credit was given for correct references to rate, rather than directly to time itself, but answers such as 'it gets quicker or slower' were too vague. Mention of an optimum temperature without any other information about time taken

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before or after this value was insufficient. Explanations were not asked for in this question.

02.4 Nearly 60% of students scored full marks in this question, but of the 20% awarded zero marks, the most common incorrect response seen was to use 50 as the numerator, despite the equation being given in the question. Common errors included:

- giving a final answer of 0.30 or 0.3 with a dot to indicate a recurring number, in which case a maximum of 2 marks was considered.
- use of a time from a temperature other than 50 °C, in which case a maximum of 1 mark was given if the correctly calculated value was rounded to 1dp.
- incorrect calculation of a correct substitution (10÷33) giving an answer of 3.3, in which case a maximum of 1 mark was given for MP1.
- use of the figure for temperature, 50 °C, instead of 33 in the equation, in which case no marks were awarded.

02.5 74% of students achieved the mark in this question.

02.6 Three quarters of students achieved the mark in this question.

02.7 Nearly 70% of students scored full marks in this question, with a further 26% scoring one mark.

4.4.1.2 Rate of photosynthesis

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Question 6 (Low demand)

06.1
Almost 60% of students knew that pondweed gets its energy from sunlight.

06.2
The question asks for the student to interpret the food web given on the paper. Only half of students were able to identify a primary consumer from the food web. There was a range of answers showing that some students were not sure of the terminology of a food chain and where a primary consumer would correctly be found. A few students did not refer to the given food web and made up their own primary consumer – some examples being an eagle, a tiger, or a shark.

06.3
Over three quarters of students identified the correct pyramid of biomass for the food web.

06.4
Around half of students knew that 1% of the biomass in the algae is transferred to the fish.

06.5
Only 20% of students gained no marks in this question – with 40% of them knowing that energy is lost from organisms via faeces and movement. A further 40% scored one mark for identify one method.

06.6
Students were presented with a tally chart and asked to convert the tallies into numbers for each organism. If all 3 totals were correct, then the student was awarded 2 marks – which was the case for 85% of students. If one or two were correct they were awarded only 1 mark. The few students that did not understand tally charts either copied the lines or did not attempt the question.