AQA GCSE BIOLOGY (HIGHER) · 8461

BIOLOGY



MARK SCHEME

4.4.1 PHOTOSYNTHESIS (PACK 4)

SCORE	PERCENTAGE
/169	%

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Q1.

(a) glucose

1

oxygen

1

extra ticks negates marks

(b) count the number of bubbles produced in 1 minute

1

measure the volume of gas produced in 30 seconds

1

extra ticks negates marks

(c) any **one** from:

- to control the temperature

  allow so pondweed / solution did not warm up

- temperature affects the rate of photosynthesis

  allow correct description of effect of temperature on rate
  allow high temperatures denature enzymes
  ignore references to limiting factors

1

ignore reference to 'it'

(d) 52

1

(e) all points plotted correctly

allow ± ½ a square
*allow **1** mark for three points correctly plotted*

2

smooth curve drawn through all points

ignore extensions of line / curve unless inconsistent with line / curve drawn

1

(where a bar chart has been plotted)
*allow **1** mark for all bars plotted correctly*
if points are plotted as well as bars, ignore bars

(f) any **one** from:

- the nearer the light source to the pondweed the faster the rate of photosynthesis

  allow the nearer the light source to the pondweed the faster the bubbles produced

- the greater the light intensity the faster the rate of photosynthesis

  allow the greater the light intensity the faster the bubbles produced

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allow the closer the light source the more the plant photosynthesises

ignore more bubbles are produced with no reference to rate

allow oxygen for bubbles

*do **not** accept carbon dioxide*

1

allow converse statements for all marking points

[10]

Q2.

(a) $6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$

1

(b) endothermic

1

(c) measure the volume of gas released

allow use a measuring cylinder / capillary tube / (gas) syringe

1

increase length of time

allow sensible length of time

allow video the investigation so you could re-count the bubbles later

*allow repeat the measurement at each distance several times **and** calculate a mean*

ignore references to using other distances

1

(d) temperature affects **rate** of photosynthesis
or
temperature affects **rate** of bubble production

allow correct description of effect of temperature on rate

1

(because) reaction / photosynthesis is controlled by **enzymes**

allow high temperatures denature enzymes

enzymes being denatured must be linked to high temperature

1

(e) evidence of squaring for **two** distances that double:
25 **and** 100
or
100 **and** 400

1

calculate $1/d^2$ for **two** distances that double:
0.04 **and** 0.01
or
1/25 **and** 1/100
or

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0.01 **and** 0.0025
or
1/100 **and** 1/400

*allow **2** marks for these calculations without working*

ignore calculations for a third distance as long as two where the distance doubles are correct

1

(therefore as distance doubles) light intensity is quartered

1

(f) 2 (bubbles would be produced)

1

(as) very little light / energy for photosynthesis to occur

*do **not** accept no light*

1

*allow **2** marks for a quarter of the bubbles are produced as light distance doubles so 2 bubbles would be expected*

(g) (independent variable)
use different concentrations of sodium hydrogencarbonate solution

allow three concentration values

ignore different concentrations of carbon dioxide

1

(control variables)

***max 2** marks for control variables*

any **two** from:

- distance from light source

  allow light intensity
  ignore light unqualified
  ignore same lamp

- temperature of solution
- same plant

  allow type / size of plant

- time for plant to equilibrate

  allow time for plant to adjust to different solution
  ignore time unqualified

2

[14]

Q3.

(a)

Factor	Biotic	Abiotic
Diseases	✓	
Herbivores	✓	

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Temp		✓
Water		✓

*allow **1** mark for 2 or 3 correct*

2

(b) (leaves block light near tree so) more light (as you move outwards)

allow low light intensity under tree
ignore Sun

1

for photosynthesis

allow less photosynthesis under the tree

1

(which) produces (more) glucose / proteins (for growth)

ignore growth
ignore food

allow molecules, cell components or other correct substances instead of proteins

if no other mark awarded allow less water / ions / minerals / nutrients under the tree

1

(c) quadrat

correct spelling only

1

light meter

allow lux meter
allow light intensity meter
allow light data logger

1

in this order

(d) 1.5(0) (m^2)

allow 15 000 cm^2

1

(e) to keep light (intensity) as similar as possible

allow the light (intensity) might change

ignore references to temperature
ignore weather
ignore Sun

1

(f) any **one** from:

- repeat (investigation) around the tree

  allow repeat in different directions

- repeat (investigation) for other trees / areas
- sample every one metre
- count the number of each species present (rather than percentage cover)

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ignore repeats unqualified
ignore repeat at different times / days / seasons
ignore different size quadrat
ignore random sampling

1

(g) daisy

1

(h) as light (intensity) increased so did the percentage / cover of plants

ignore directly proportional
ignore positive correlation unqualified

1

up to 100% / maximum at 175 (arbitrary units)

ignore distance

1

(i) any pair from:

- (lack of) water / rain (1)

  because the leaves are stopping the rain
  or
  because the roots of the tree are absorbing it (1)

  allow soil moisture

- (lack of) minerals / ions (1)

  allow magnesium / nitrate / nutrients

  because the tree (roots) have absorbed them (1)

- temperature (1)

  allow too cold / cooler

  because less thermal energy from the sun is reaching under the tree canopy (1)

  allow 'heat' for thermal energy

  allow pH / acidity (1)
  because (some) fallen leaves are acidic (1)

2

ignore carbon dioxide
*do **not** accept oxygen*

[15]

Q4.

(a) any **two** from:

- amino acids
- glycerol
- fatty acids

*do **not** accept fat*

allow salt / minerals
allow vitamins

2

(b) 11.79 (g)

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allow 11.8 (g) ***or*** *12 (g)*

1

(c) **Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

5–6

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

- carbon dioxide enters the leaf through stomata
- glucose / sugars produced by photosynthesis (in leaves)
- some detail of photosynthesis
- transport / translocation (of glucose / sugars)
- in phloem
- glucose is converted to starch
- (starch is a) long chain of glucose / sugar molecules
- starch as storage (of glucose / sugars)

[9]

Q5.

(a) carbon dioxide + water → (glucose) + oxygen

allow reactants in either order

allow correct formulae, balancing not required

1

(b) chlorophyll

1

(c) glucose (produced in photosynthesis) is converted into starch

1

(d) starch could be broken down (into sugar)

1

(e) so the colour of the iodine solution / result can be seen

1

(f) any **one** from:

- turn off Bunsen / flame before collecting ethanol
- use a water bath to heat the ethanol

allow idea that there are no naked flames near the ethanol

1

(g) **A** orange / brown

1

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B black / blue-black

1

[8]

Q6.

(a) any **two** pairs from:

- light (intensity)
- more light means more / faster photosynthesis / glucose

1
1

- temperature
- higher temperature more / faster photosynthesis

1
1

- water
- right amount for transpiration / cell function / photosynthesis

- soil pH / ions
- needed for healthy growth

ignore 'growth' unqualified

ignore carbon dioxide and oxygen

(b) hand lens

1

moth guide

1

(c) any **one** from:

- can work gently and not disturb moths
- moths might fly away outside

1

(d) any **one** from:

- damage to eyes (from UV / bright light)
- burns from hot lamp
- diseases / pathogens from wild organisms

1

(e) any **one** from:

- wear sunglasses
  or
  eye protection
- wear gloves or allow lamp to cool.
- wear gloves
  or
  wash hands after handling moths

answer must relate to hazard

1

(f) bristles / hairs make it unpleasant to eat

or

bright colour acts as warning to predators (that it is poisonous)

1

[10]

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Q7.

(a) 2 640 000 (in remaining 24 years)

1

110 000 in each remaining year
or
2.64×10^6 in remaining 24 years

1

1.1×10^5

*an answer of 1.1×10^5 scores **3** marks*

1

(b) (area of woodland =) 21 600

allow 16 800 + 4 800
or 9 000 + 12 600
or 4 800 + 4 200 + 12 600

1

518 400 (bluebells)

allow their area × 4 × 6
*an answer 518 400 (bluebells) scores **2** marks*

1

(c)

Level 3: Relevant points are identified, given in detail and logically linked to form a clear account.	5-6
Level 2: Relevant points are identified, and there are attempts at logically linking. The resulting account is not fully clear.	3-4
Level 1: Relevant 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 **reducing pollution** • trees take in carbon dioxide • which will lower atmospheric greenhouse gases and reduce global warming (allow consequences of global warming) • trees act as noise absorbers • which will reduce noise pollution in the city • roots of trees will bind the soil • which will reduce local flooding and soil erosion • leaves on trees will trap PM2.5 / tiny particulates	

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• which will reduce asthma/breathing difficulties of people **increasing biodiversity** • new woodlands or new trees in parks / gardens will provide new habitats • for new species of plants and animals • linking woodlands • will allow animals to move into new areas • planting many new species of trees • will provide food and shelter for new species of insects/birds • could extend the scheme • to reintroduce species of plants or animals which no longer live in that area • could protect wildlife in the area • by legislation or community projects	

6

[11]

Q8.

(a) temperature

1

carbon dioxide concentration

allow type of pondweed

allow mass of pondweed

1

(b) $\frac{(34 + 31 + 31 =)96}{3}$

*allow **1** mark for*

$\frac{22 + 34 + 31 + 31 =)118}{4} = 29.5$

2

$\frac{32}{2(\text{min})}$

= 16(.0) (bubbles per minute)

allow ecf from incorrect mean

1

(c) 2.3(333)

1

(d) place different coloured filters over the lamp bulb

or

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use different coloured light bulbs

1

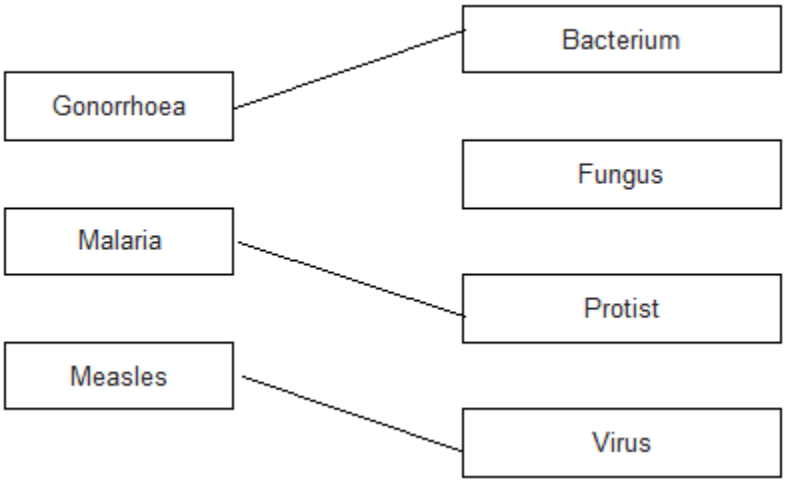
keep the lamp the same distance from the pondweed each time

1

[8]

Q9.

(a)



3

(b) (trachea) has mucus

1

to <u>trap</u> pathogens

1

(trachea) has cilia

1

to <u>move</u> mucus out of trachea

1

(c) **dependent variable:**
number of times mosquitoes landed on socks

1

control variable:
any **one** from:

- number of mosquitoes in each container
- length of time socks worn
- dampness of socks
- same type of socks
- size of container
- time
- temperature
- species of mosquito
- age of mosquito

1

(d) use worn socks

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or
use chemical from worn socks

1

to attract / trap infected mosquitoes

1

or accept:
wear clean socks / change socks regularly (1)
to reduce the chance of attracting mosquitoes (1)

(e) less chlorophyll present

1

(so) less light absorbed

1

(so) reduced photosynthesis
or
(so) less sugar / food made

1

[14]

Q10.

(a) water + carbon dioxide → oxygen + glucose
extra box ticked negates mark

1

(b) **Level 3 (5–6 marks):**
A coherent method is described with relevant detail, which demonstrates a broad understanding of the relevant techniques and procedures. The steps in the method are logically ordered. The method would lead to the production of valid results.

Level 2 (3–4 marks):
The bulk of the method is described with mostly relevant detail, which demonstrates a reasonable understanding of the relevant scientific techniques and procedures. The
method may not be in a completely logical order and may be missing some detail.

Level 1 (1–2 marks):
Simple statements are made which demonstrate some understanding of some of the relevant scientific techniques and procedures. The response may lack a logical structure and would not lead to the production of valid results.

0 marks:
No relevant content

Indicative content
- description of how the apparatus would be used
- reference to control intensity of light / brightness
- use of ruler to measure distance of light from beaker / pondweed
- reference to varying colour of light or use of different filters
- plant releases gas / oxygen
- measure number of bubbles / volume of gas produced
- same length of time
- reference to control of temperature
- reference to control / supply of carbon dioxide in water

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- do repeats and calculate a mean

6

(c) rate does not increase further if light intensity increased beyond 20

allow graph levels off after 20

1

(d) any **one** from:

- temperature
- carbon dioxide (concentration)
- amount of chlorophyll

allow number of chloroplasts

1

[9]

Q11.

(a) control

1

to check that the indicator colour does not change on its own
or
to check any changes in colour are due to the organisms

1

(b) (tube) **E**

1

most carbon dioxide

1

(due to) only respiration occurring

allow no carbon dioxide used for photosynthesis

*allow **1** mark **max** if chose tube **D** and give a correct reason*

1

(c) the amount of carbon dioxide produced by respiration equalled amount absorbed for photosynthesis

1

[6]

Q12.

(a) (placed) randomly

allow description of placement

1

sufficient number (of quadrats) used

1

count (dandelions) in each quadrat

1

use mean number of dandelions, area of quadrat and area of field to estimate population

accept (area of field / area quadrat) × mean number of dandelions per quadrat

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1

(b) (40 × 145) / 0.25 = 23 200

1

(0.42 × 23 200 =) 9744

*allow 9744 with no working shown for **2** marks*

*allow ecf from correct attempt at the previous step) × 0.42 for **1** mark*

1

(c) **Level 2 (3–4 marks):**
A detailed and coherent explanation is given. Logical links between clearly identified relevant points are made to explain why dandelion growth may be limited.

Level 1 (1–2 marks):
Discrete relevant points are made. The logic may be unclear.

0 marks:
No relevant content

Indicative content

factors that may be considered:
competition for resources including:
- light
- water
- space
- mineral ions (allow nutrients / salts / ions from the soil)

reference to why growth may be limited:
- (light) energy for photosynthesis
- water as a raw material for photosynthesis / support
- surface area exposed to light
- sugar / glucose produced in photosynthesis
- (space) to grow bigger
- (space) for growth of root system
- (mineral ions) for growth
- (mineral ions / sugar) for production of larger molecules **or** named example

4

[10]

Q13.

(a) $6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$

correct reactants

1

correct products

1

(b) correct scale and label on x axis

1

all 5 plots correct

tolerance ±½ small square

*allow 2 or 3 plots correct for **1** mark*

2

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(c) no

no mark

although as distance increases, rate decreases

1

the line curves **or** line should be straight

1

suitable data quoted

examples:

- *supports conclusion between 20–40 (cm)*
- *does not support conclusion between 10–20 (cm)*

1

(d) volume of 1 bubble = $4 / 3 \times 3.14 \times (0.1)^3$

1

= 0.00419

1

at 40 cm there are 7 bubbles

1

vol at 40 cm = 0.02933

allow ecf from incorrect value taken from table

1

Rate per minute = × 2

= 5.86×10^{-2} (cm^3 per min)

*allow 5.86×10^{-2} with no working shown for **5** marks*

1

*answer not given in standard form or to incorrect number of sig. figs max **4** marks*

[13]

Q70.

(a) (i) 214 (billion tonnes)

*allow **1** mark for reading 122 and 92 correctly*

*allow **1** mark for the correct addition of incorrect readings*

2

(ii) 18.35

allow 18.4

*do **not** allow 18.3*

1

(b) (i) (only) a small mass of carbon (dioxide) is released from burning fuels (compared to other processes)

allow the carbon (dioxide) released from other processes / respiration and decomposition is (much) greater

1

(ii) any **two** from:

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- (more) plants would absorb (more) carbon (dioxide)
- (due to more) photosynthesis

  an idea of more is needed at least once
- fewer animals would release less carbon (dioxide)
- (due to less) respiration (in animals).

  an idea of a reduction is needed at least once

  ignore references to oxygen

2

[6]

Q71.

any **six** from:

*only credit release of carbon dioxide **once** when linked to a correct process*

ignore references to burning

- (plants) photosynthesise
- *(plants)* take in carbon dioxide
- *(plants)* produce carbohydrates / fats / proteins

  accept produce glucose
- (carbon compounds transferred by) feeding
- respiration
- breaks down carbon compounds / carbohydrates

  accept glucose
- releases carbon dioxide
- organisms die / produce wastes / *excrete*
- (which are) decomposed / decayed by microorganisms

  allow broken down

  allow bacteria / fungi / microbes / decomposers
- (which) release carbon dioxide

[6]

Q72.

A – respiration

ignore breathing

1

B – feeding / eating

allow consumption / ingestion / feeds

ignore nutrition / food

*do **not** accept digestion*

1

C – photosynthesis

1

D– combustion / burning

1

[4]

Q73.

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plants absorb CO_2 for photosynthesis

ignore carbon

1

all organisms / any named organism respire(s) and release(s) CO_2

ignore breathing

ignore carbon

1

any **four** from:

- carbon compounds / named compound made by plants
- plants eaten by animals
- dead organisms / faeces are decomposed / decayed

  allow broken down
- by bacteria / microorganisms
- dead plants and animals (may) form fossil fuels
- when (fossil) fuels are burnt they release CO_2 into the air

4

[6]

Q74.

(a) (i) photosynthesis

allow phonetic spellings

1

(ii) respiration

allow phonetic spellings

ignore breathing / decay

1

(b) any **two** from:

- burn / use less fossil fuels
  or
  reduce industrial processes
  or
  use cars less

  allow cycle / use buses / walk / trains / public transport

  allow stop for reduce in all cases
- reduce deforestation

  accept named example

  or

  plant more trees

  allow plants
- use alternative sources of energy

  accept solar / wind / nuclear / hydroelectric / wave / tidal /

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geothermal
ignore renewable / biomass

- trap CO_2 in sedimentary rocks / underground / under sea
  or
  carbon capture / CCS

- rear less cattle / animals
  allow eat less meat
  allow <u>reduce</u> growth of human population
  ignore reduce the human population

2

[4]

Q75.

read 'the gas' or 'it' as carbon dioxide

(plants) photosynthesise

1

(plants) absorb <u>carbon dioxide / CO_2</u> (from the air)
allow take in / use <u>carbon dioxide / CO_2</u> (from the air)

1

(overall) <u>more carbon dioxide / CO_2</u> is being released into the air than is being removed
*allow 470 (billion tonnes) released **but / and** 450 (billion tonnes) taken in*

1

(by) <u>respiration</u> (by all organisms / any named organism)
ignore breathing
ignore carbon

1

(and) combustion / burning
ignore carbon

1

(so) amount of <u>carbon dioxide / CO_2</u> in air is increasing
allow 20 (billion tonnes) of <u>carbon dioxide / CO_2</u> added to air each year

1

[6]

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Q1.

(a) 44% of students achieved both marks for identifying glucose and oxygen as the products of photosynthesis. 20% of students were awarded zero marks. Most of these had selected the reactants of photosynthesis, carbon dioxide and water.

(b) 77% of students scored one or more marks for this question. Many realised that counting the number of bubbles produced in one minute would be more accurate than counting them in 30 seconds.

(c) 36% of students achieved this mark. Many responses were poorly expressed confusing heat and temperature. Many said that temperature was a limiting factor, which was ignored.

(d) 70% of students calculated that 52 bubbles would be produced in two minutes when the light source was 10 cm from the pondweed. The most common error was to multiply the number of bubbles produced in 30 seconds by two, rather than by four.

(e) When plotting graphs it's advisable to use a pencil so errors can be erased. Some students plotted dots instead of crosses. Dots cannot always be seen.

28% of students achieved full marks for plotting the graph and drawing a suitable line of best fit, which was a curve through all the points. Very thick lines or sketchy, double or broken lines were insufficient.

56% of students achieved two marks for plotting all the points correctly. A mark was sometimes missed because the final point, where no bubbles were produced, was not plotted.

(f) 19% of students gave a suitable conclusion. Many described the pattern shown in the graph, but a reference to the rate of photosynthesis, or rate of bubble production was required. Rate could be expressed as faster, or with a reference to time.

Q2.

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

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

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

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

Alternative ideas that gained credit included:

- using a video so the bubbles could be recounted afterwards

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- repeating the measurements and calculating a mean (the whole of this statement was required for a mark).

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

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

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

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

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

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

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

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

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

Q3.

Foundation

(a) 70% of students achieved at least one mark. The most confusion appeared to be whether diseases / herbivores were biotic or abiotic.

(b) Most students achieved one mark for identifying the importance of more light as one moves further away from the tree, with a significant number gaining the second mark for the link to photosynthesis. There were, however, a good number of responses only referring to Sun which was not creditworthy.

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Very few (less than 1%) got maximum marks for stating production of proteins/glucose. Many students referred to food being made which was insufficient. It was common for students to make two creditworthy points about 'light' and 'less water / minerals', but only achieving the single mark on offer

(c) This question asked for the name of two pieces of equipment that would have been used.

- Quadrat was the most popular correct answer, although some missed out on the mark for incorrect spelling.
- Light meter was rarely encountered. Answers often referred to ammeters, voltmeters and light sensors, solar panels and arbitrary measurers.

27% of students achieved at least one mark.

(d) This calculation was very difficult for students, with 3% answering correctly. They were asked for the total area sampled. Many attempted to calculate the area of the circle in the diagram. It was also quite common to see answers for area of a quadrat multiplied by 5 rather than by 6.

(e) Students were asked to suggest a reason why the investigation was done as quickly as possible on the same day. 28% of students referred to the idea of light intensity being controlled. However, many gave insufficient answers about the Sun, weather or temperature being the same.

This question was often approached from two perspectives, both of which were creditworthy with a reference to light. Either, why it was done as quickly as possible or why it was done on the same day.

(f) There was a huge variety of suggestions about how the investigation could be improved. 17% of students identified sampling at a smaller distance or repeating under another tree.

Popular misconceptions seen referred to extending the transect, using a bigger quadrat or repeating the investigation at a different time. One particularly popular response seen was to do it more slowly. This had clearly been derived from the stem of the previous question. There were also a number of responses which simply suggested repeating it which were insufficient.

(g) This question asked students to identify which plant species would only grow at high light intensity. 42% of students were able to give 'daisy'. The most popular incorrect answer was clover, possibly because it was the species with the highest percentage coverage at high light intensity.

(h) Students were asked to make a conclusion about the relationship between light intensity and the total percentage cover of plants. 24% students achieved the first mark point but the second one was rarely seen.

The two most popular incorrect responses were those that only referred to number of plants rather than cover or percentage and those who stated the relationship the wrong way around e.g. 'as percentage cover increases so does the light intensity'.

(i) Students were asked to suggest another factor which may have caused the results obtained. Generally many students gave water, minerals and a few gave temperature as a correct factor. However, very few responses then linked the factor to how the tree would cause the results and subsequently, the second mark was awarded much less often. Common misconceptions for the factor mark were carbon

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dioxide and moisture. Trampling was also seen but was not creditworthy. 5% of students achieved full marks.

Higher

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

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

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

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

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

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

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

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

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

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

Q4.

Foundation

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(a) 83% of students gave the incorrect answers of fat, protein or fibre, demonstrating a lack of understanding of digestion. Glucose, sugars and carbohydrates were also frequently seen, which did not score a mark, given the way the question was phrased.

(b) 28% of students could calculate the mass of sugars in 180 g of sweet potato, when given the mass of sugars in 100 g of sweet potato.

(c) 'Level descriptors' are used to mark 'extended response' questions such as this. Level 2 and level 3 answers require students to make unprompted links between aspects of an explanation. For example, responses that only referred to processes in the leaf rarely contained relevant links to answer the question. 3% of students were able to answer sufficiently to enter level 2 or level 3.

Many students incorrectly refer to carbon dioxide mixing with water in an attempt to describe photosynthesis. Major misconceptions were frequent, such as carbon dioxide being taken into the roots from the soil, and photosynthesis occurring in the roots.

Higher

(a) 86% of students gave the incorrect answers of fat, protein or fibre, demonstrating a lack of understanding of digestion. Glucose, sugars and carbohydrates were also frequently seen, which did not score a mark, given the way the question was phrased.

(b) 65% of students could calculate the mass of sugars in 180 g of sweet potato, when given the mass of sugars in 100 g of sweet potato.

(c) 'Level descriptors' are used to mark 'extended response' questions such as this. Level 2 and level 3 answers require students to make unprompted links between aspects of an explanation. For example, responses that only referred to processes in the leaf rarely contained relevant links to answer the question. 18% of students were able to answer sufficiently to enter level 2 or level 3.

Many misconceptions regarding photosynthesis were seen, such as roots absorbing carbon dioxide for photosynthesis and carbon dioxide being used in respiration.

Q70.

(a) (i) Just over a third of the students gained full marks for this question. 1 mark could be gained for correctly reading 122 and 92 from the graph. Incorrect readings that were correctly added together could also gain 1 mark. This highlights the importance of showing working for all calculations, no matter how simple the calculation may appear to be.

(ii) Some students attempted to write out the number in full, or in standard form, but could only gain the mark if they had deleted billion from the answer line. There were some avoidable errors made, such as writing 1.835 instead of 18.35. Others divided 5 by 3.67 instead of multiplying the numbers together.

(b) (i) Students were instructed to use information given in the graph to suggest why some scientists do not think that burning fuels is the main cause of carbon dioxide in the atmosphere. Many said that respiration and decomposition released more carbon than burning fuels to gain the mark. If figures were quoted, a comparison was needed. Some students gave confused responses about photosynthesis, which did not answer the question

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which was about burning and the release of carbon dioxide.

(ii) Students had to suggest how eating less food from animals and eating more food from plants could reduce the amount of carbon dioxide in the atmosphere. Credit could not be gained just for mentioning respiration or photosynthesis alone. Clear statements as to whether these processes would occur more or less were needed, and how this would affect the amount of carbon dioxide absorbed or released. Many students linked in to the idea of decomposition of dead organisms, which was ignored. Some spoke about carbon dioxide being produced by the meat production processes, or from cooking the meat, which was also ignored. Others focused their responses on oxygen, which did not answer the question.

Q71.

The question was generally well answered and discriminated very well with the full range of marks being awarded in roughly equal proportions. Students answered the question in a variety of ways. Some described processes in a food chain, talking mainly about feeding and decomposition, whilst other, more able students, gave a full description beginning with photosynthesis. Some less able students did not restrict their responses to the woodland community and described the burning of fossil fuels in power stations, removal of timber to make paper, humans burning trees and carbon dioxide being absorbed in the oceans.

Marks were frequently missed when students referred to plants and animals breathing, rather than respiring. Confused statements such as “Plants and animals give out carbon dioxide during photosynthesis”, or “Carbon dioxide is given out during respiration and photosynthesis” meant that marks were lost. Students need to organise their answers logically, for example by referring to photosynthesis and respiration as separate ideas.

Q72.

The carbon cycle is a new topic for this specification, which was reflected in few students gaining top marks. Many responses used words from Question (b) about variation and evolution. Pollution or decay was seen frequently for D, combustion. The most common correct responses were either photosynthesis or respiration. As a process was asked for, an answer such as ‘food’ was not enough for the feeding mark.

Q73.

It was encouraging to see many excellent answers gaining five or six marks. Failure to gain full marks was usually due to not using the technical terms photosynthesis or respiration, or giving confusing accounts of decay and fossilisation. Most students were able to gain at least one mark for this question.

Q74.

(a) (i) Almost two-thirds of students were able to identify photosynthesis as the process used to remove carbon dioxide from the air.

(ii) Fewer students were able to identify respiration as the process by which all

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organisms release carbon dioxide.

(b) There were many suggestions students could have made to reduce the amount of carbon dioxide in the atmosphere, but the majority used the picture in the question for ideas. Plant more trees and burn less fuels were common answers. Some listed several suggestions for burning less fuels, such as walk, use cars less and reduce industrial processes, but there was only one mark for these. Many said use renewable energy sources, but this on its own was not enough for the mark as burning biomass would release carbon dioxide. A specific example was needed, such as solar or wind power. The majority of students were able to score at least one mark for this question.

Q75.

The majority of students made a good attempt to answer this question. Many gained marks for stating the processes shown on the diagram, namely photosynthesis, respiration and combustion. A few linked the processes to an incorrect direction of carbon dioxide transfer, so negating the mark. Others demonstrated a good understanding of the carbon cycle and described the processes of decomposition and fossilisation, which did not gain credit as these processes were not shown on the diagram. Students found it a little more difficult to gain the marks for explaining the effects of the processes on the mass of carbon dioxide in the air. A comparison of the amount absorbed and released was required for one mark, and an overall conclusion that the amount in the air is increasing for the last mark. Just over a tenth of students scored five or six marks.

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