A student investigated the effect of light intensity on the rate of photosynthesis.

The diagram shows the apparatus the student used.

This is the method used.

1. Set up the apparatus as shown in the diagram above.
2. Place the lamp 10 cm from the pondweed.
3. Turn the lamp on and count the number of bubbles produced in one minute.
4. Repeat with the lamp at different distances from the pondweed.

(a) Complete the hypothesis for the student’s investigation.

‘As light intensity increases, ________________________________ ________________________________ .’

(b) What was the independent variable in this investigation?

Tick one box.

- Light intensity
- Number of bubbles produced
- Temperature
- Time
(c) The teacher suggests putting the boiling tube into a beaker of water during the investigation.

Suggest why this would make the results more valid.

___________________________________________________________________
___________________________________________________________________

Table 1 shows the student’s results.

<table>
<thead>
<tr>
<th>Distance of lamp from pondweed in cm</th>
<th>Number of bubbles produced per minute</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
</tr>
<tr>
<td>10</td>
<td>67</td>
</tr>
<tr>
<td>20</td>
<td>61</td>
</tr>
<tr>
<td>30</td>
<td>53</td>
</tr>
<tr>
<td>40</td>
<td>30</td>
</tr>
<tr>
<td>50</td>
<td>13</td>
</tr>
</tbody>
</table>

(d) Calculate value X in Table 1.

___________________________________________________________________
___________________________________________________________________

\[ X = \text{______________________ bubbles per minute} \]  

(e) State one error the student has made when completing the results at 20 cm.

___________________________________________________________________
___________________________________________________________________

(1)
(f) What evidence in Table 1 shows that the data is repeatable?

Tick one box.

- The number of bubbles decreases as distance decreases.
- The numbers of bubbles at each distance are similar.
- The student calculated a mean for each distance.
- The student did the experiment three times.

Another student investigated the effect of the colour of light on the rate of photosynthesis.

The results are shown in Table 2.

<table>
<thead>
<tr>
<th>Colour of light</th>
<th>Rate of photosynthesis in arbitrary units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>24</td>
</tr>
<tr>
<td>Green</td>
<td>4</td>
</tr>
<tr>
<td>Red</td>
<td>17</td>
</tr>
<tr>
<td>Yellow</td>
<td>8</td>
</tr>
</tbody>
</table>
(g) Plot the data from **Table 2** on the graph.

You should label the x-axis.

(h) Give **two** conclusions from the graph above.

1. _________________________________________________________________
___________________________________________________________________

2. _________________________________________________________________
___________________________________________________________________
(i) The glucose produced in photosynthesis can be converted into amino acids to make new proteins for the plant.

Complete the sentences.

The glucose produced in photosynthesis can also be used in other ways.

Glucose can be used in respiration to release ________________ .

Glucose can be converted to cellulose to strengthen the ________________ .

Glucose can be stored as ________________ .

(3)

(Total 14 marks)
The graph shows information about the yield of cereal crops grown in the European Union.

(a) Calculate the increase in the yield of cereal between 1970 and 2010.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

Increase in yield = ____________________ tonnes/hectare

(2)

(b) Estimate by what fraction the yield of cereal increased between 1971 and 1992.

Tick one box.

1 \[\frac{1}{10}\] 1 \[\frac{1}{3}\] 1 \[\frac{1}{2}\] 3 \[\frac{3}{4}\]

(1)
(c) The increase in yield is partly due to increased use of nitrate fertilisers.

Which substance do plants make using nitrate ions?

Tick one box.

- Cellulose
- Fat
- Protein
- Starch

(d) The yield of cereal in 2004 was much greater than the yield in 2003.

Suggest three possible reasons for the increased yield in 2004.

Tick three boxes.

- A genetically-modified variety of seed was sown in 2004.
- A pathogenic fungus grew on the cereal in 2004.
- Farmers added more nitrate to the soil in 2003.
- More cereal seeds were sown in 2003.
- More rain fell in spring and early summer in 2004.
- The mean summer temperature was lower in 2003.
Humans eat cereals.
Humans also eat the animals that feed on cereals.

**Figure 1** and **Figure 2** show two food chains.

**Figure 1**

![Food Chain 1](image1)

**Figure 2**

![Food Chain 2](image2)
(e) Which pyramid of biomass is correct for the food chain shown in Figure 2?

Tick one box.

In Figure 1, 1 hectare of cereal crop would provide enough energy for 8 people for a year.

In Figure 2, 10 hectares of cereal crop would be needed to provide enough energy for only 1 person for a year.

(f) It is much more efficient for humans to get energy by eating cereals than by eating chickens.

Calculate how many times more efficient.

___________________________________________________________________

___________________________________________________________________

Answer = ____________________ times
(g) Why is it more efficient for humans to get energy by eating cereals than by eating chickens?

Tick two boxes.

Cereals gain extra energy from mineral ions in the soil.

Chickens contain more protein per gram than cereals.

Chickens use energy for movement and for keeping warm.

Much of the food eaten by chickens is wasted as faeces.

Not all parts of the cereal plants are edible.

(2)
(Total 11 marks)

3 Glucose is broken down in respiration.

(a) What is the chemical formula for glucose?

Tick one box.

C₆H₆O₆

C₃H₆O₃

C₆H₁₂O₆

C₆H₁₀O₆

(1)
The diagram shows the apparatus a student used to investigate aerobic respiration.

**Diagram:**

- **Air in** → Flask A → Flask B → To pump
- Flask A contains Limewater and Woodlice.
- Flask B contains Limewater.

Limewater goes cloudy when carbon dioxide is added to it.

(b) After 10 minutes the limewater in flask B was cloudy, but the limewater in flask A remained colourless. Explain why.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)

(c) Flask A acts as a control in this investigation. What is the purpose of a control?

___________________________________________________________________
___________________________________________________________________

(1)

(d) The student repeated the investigation with no woodlice. Describe the appearance of the limewater in flask A and flask B after 10 minutes.

Flask A ____________________________________________________________
___________________________________________________________________

Flask B ____________________________________________________________
___________________________________________________________________

(2)
Anaerobic respiration is another form of respiration in living organisms.

(e) What is produced during anaerobic respiration in humans?

Tick one box.

- Carbon dioxide
- Carbon dioxide and lactic acid
- Lactic acid
- Oxygen and water

(f) Complete the equation for anaerobic respiration in yeast.

\[
\text{glucose} \rightarrow \text{carbon dioxide} + \text{________________________}
\]

(Total 8 marks)

The image below shows part of a root from a cress plant.

(a) What type of microscope was used to create the image above?

___________________________________________________________________

(1)
(b) The magnification of the cress root in the image above is × 200.
There are 1000 micrometres (μm) in a millimetre (mm).
Calculate the real length of the root hair, \( X \).
Give your answer in micrometres (μm).

Real length \( X = \) ____________________ μm

(2)

(c) Root hair cells take up water from the soil.

Explain one way in which the root hair cell is adapted to this function.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)

The table shows the water uptake by a plant’s roots on two different days.

<table>
<thead>
<tr>
<th>Mean water uptake in cm³ per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold day</td>
</tr>
<tr>
<td>Hot day</td>
</tr>
</tbody>
</table>

(d) Explain why the mean rate of water uptake is higher on a hot day than on a cold day.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(3)
(e) The concentration of mineral ions in the soil is lower than in root hair cells.
Root hair cells take up mineral ions from the soil.
Root hair cells contain mitochondria.

Explain why root hair cells contain mitochondria.
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(Total 12 marks)

Amylase is an enzyme found in the human body.
Amylase breaks down starch into sugars.

(a) Where is amylase produced in the human body?

Tick one box.

Liver and pancreas

Liver and stomach

Salivary glands and pancreas

Salivary glands and stomach

(1)
(b) Enzymes speed up chemical reactions.

Explain how amylase breaks down starch.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(c) One sugar in the body is glucose.

Glucose is used for respiration.

Give one other use for glucose in the body.

___________________________________________________________________

(d) A student investigated the effect of temperature on the activity of human amylase.

This is the method used.

1. Put 2 cm³ of 1% starch solution into a boiling tube.
2. Put 2 cm³ of amylase solution into a second boiling tube.
3. Put both boiling tubes into a water bath at 20 °C.
4. After 5 minutes, mix the amylase and the starch together in one boiling tube.
5. After 30 seconds, add a drop of the starch and amylase mixture to a drop of iodine solution in one well of a spotting tile.
6. Repeat step 5 until the iodine solution no longer changes colour.
7. Repeat steps 1 – 6 at 40 °C and at 60 °C and at 80 °C

Why did the student leave the starch and amylase solutions in the water bath for 5 minutes in step 3?

___________________________________________________________________
___________________________________________________________________
(e) The temperature of the human body is 37 °C

The diagram below shows the results of the investigation at 20 °C and at 80 °C

Complete the diagram to show the results you would expect at 40 °C and at 60 °C

You should write a tick or a cross in each well of the spotting tile.

Key
✓ Starch present
✗ Starch not present

![Spotting tile diagram]

(f) There are different ways to investigate the breakdown of starch by amylase.

One other method is to measure the concentration of starch present in the solution every 30 seconds.

Why is this method better than the method the student used?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)
A colorimeter can be used to measure the concentration of starch present in the solution every 30 seconds.

A colorimeter measures the amount of light that cannot pass through a solution. This is known as absorbance.

Below shows a graph of absorbance against concentration of starch.

(g) The absorbance of the solution at 40 °C was 0.56 arbitrary units after 30 seconds.

What was the concentration of starch in this solution?

___________________________________________________________________

Concentration of starch = ____________________ %

(1)
(h) The concentration of starch in the solution at 20 °C after 1 minute is different from the concentration at 40 °C after 1 minute.

Explain why.
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)

(i) Predict the absorbance for the solution at 80 °C after 30 seconds.

Give a reason for your answer.

Absorbance = ______________________ arbitrary units

Reason ____________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(3)

(Total 16 marks)

All living cells respire.

(a) Respiration transfers energy from glucose for muscle contraction.

Describe how glucose from the small intestine is moved to a muscle cell.
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)
(b) The diagram below shows an experiment to investigate **anaerobic** respiration in yeast cells.

What is the purpose of the liquid paraffin in Tube **A**?

Tick one box.

- To prevent evaporation
- To stop air getting in
- To stop the temperature going up
- To stop water getting in

(1)
(c) The indicator solution in Tube B shows changes in the concentration of carbon dioxide (CO$_2$).

The indicator is:

• **blue** when the concentration of CO$_2$ is very low

• **green** when the concentration of CO$_2$ is low

• **yellow** when the concentration of CO$_2$ is high.

What colour would you expect the indicator to be in Tube B during maximum rate of anaerobic respiration?

Tick one box.

Blue  
Green  
Yellow

(1)

(d) Suggest how the experiment could be changed to give a reproducible way to measure the rate of the reaction.

Include any apparatus you would use.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

(2)
(e) Compare anaerobic respiration in a yeast cell with anaerobic respiration in a muscle cell.

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

___________________________________________________________________

(3)
(Total 9 marks)
Mark schemes

(a) rate of photosynthesis increases
or
number of bubbles produced (in one minute) increases
or
volume of gas / oxygen produced (in one minute) increases

\( \textit{allow decreases / stays the same throughout} \)

(b) light intensity

(c) reduces the effect of heat from the lamp
or
prevents temperature affecting photosynthesis

(d) 52

(e) should be 62
or
is to 3 s.f. / not rounded

\( \textit{allow inconsistent number of significant figures / decimal places} \)

(f) the numbers of bubbles at each distance are similar

(g) x-axis correctly labelled (colour of light) and bars identified as correct colour
\( \textit{bars can be identified by labels beneath the x-axis or with a key} \)

bars plotted correctly

\( \text{all 4 correct} = 2 \text{ marks} \quad 3 \text{ correct} = 1 \text{ mark} \)
\( \text{if wrong type of graph drawn, max 2 marks} \)

(h) blue light gives highest (rate of) photosynthesis
\( \textit{allow ecf from candidate’s graph allow blue light is best} \)

green light gives the lowest (rate of) photosynthesis
\( \textit{allow green light is worst} \)
(i) energy

  *in this order only*

  cell wall(s)
  
  *allow cell*
  
  *do not accept (cell) membrane*

  starch / fat / oil / lipid

(a) correct figures from graph: 5.0 / 5 and 2.60 / 2.6

  2.40 / 2.4

  *an answer of 2.40 / 2.4 scores 2 marks*

  *allow correct answer from candidate’s figures from graph for 1 mark*

(b) \( \frac{1}{3} \)

(c) protein

(d) a genetically-modified variety of seed was sown in 2004

  more rain fell in spring and early summer in 2004

  the mean summer temperature was lower in 2003

(e) \[ \]

(f) 80

(g) chickens use energy for movement and for keeping warm

  much of the food eaten by chickens is wasted as faeces

(a) \( \text{C}_6\text{H}_{12}\text{O}_6 \)
(b) atmospheric air contains less carbon dioxide than exhaled air
   allow converse
   (flask B goes more cloudy because) carbon dioxide is produced in (aerobic) respiration (by woodlice)
   do not accept anaerobic respiration

(c) for comparison / to compare
   allow answers in the context of the investigation e.g.
   or
   to check that no other factor / variable is influencing the results
   to prove that the results obtained were due to the woodlice respiring and nothing else
   or
   to prove that the woodlice produced the carbon dioxide and nothing else

(d) (flask A) would remain colourless
   ignore references to clear
   allow not cloudy
   (flask B) would remain colourless

(e) lactic acid

(f) alcohol / ethanol

(a) electron (microscope)

(b) \[
\frac{30000}{200}
\]

   an answer of 150 (μm) scores 2 marks

   150 (μm)

   if answer is incorrect allow for 1 mark sight of 0.015 / 0.15 / 1.5 / 15
   allow ecf for incorrect measurement of line X for max 1 mark
(c) **either**

large surface area

allow (vacuole contains) cell sap that is more concentrated than soil water (1)

for more / faster osmosis

create / maintain concentration / water potential gradient (1)

or

allow thin (cell) walls

for short(er) diffusion distance

(d) (on hot day) more water lost

allow converse for a cold day if clearly indicated

more transpiration

or

more evaporation

so more water taken up (by roots) to replace (water) loss (from leaves)

(e) (aerobic) respiration occurs in mitochondria

*do not accept anaerobic respiration*

(mitochondria / respiration) release energy

*do not accept energy produced / made / created*

(energy used for) active transport

to transport ions, against the concentration gradient

or

from a low concentration to a high concentration

[12]

(a) salivary glands and pancreas
(b) starch / substrate fits into active site (of enzyme)

- shape of active site is unique / complementary to substrate
  - allow converse

  or
  - substrate is specific to active site / enzyme
    - allow enzyme has a high specificity for substrate

- bonds (within starch / substrate
  - or
  - between sugar molecules) are broken

(c) converted to new carbohydrates / glycogen / named organic compound (e.g. protein / fat)

(d) to allow (the starch and amylase / solutions) to equilibrate (to the temperature of the water bath)
  - or
  - to get the starch and amylase / solutions to the same temperature / 20 °C
  - or
  - to get the starch and amylase / solutions to the (same) temperature of the water bath

(e) 40 °C
- all wells contain a symbol
  - and
  - must contain at least two crossed (×) wells at the end
    - allow final three wells crossed
      (×)

60 °C
- all wells contain a symbol
  - and
  - must have fewer crossed (×) wells at the end than at 40 °C
    - allow all wells ticked (√)
    - for either mp do not allow a crossed well followed by a ticked well

(f) more accurate
- allow (so) closer to (the) true value

(because) it is a quantitative measure
- allow (it's) an actual value as opposed to an opinion

  or
  - less / not subjective
    - allow colour is only qualitative
(g) 0.07 (%)

(h) starch is broken down less quickly (at 20 °C)
   
   allow converse

   because, at 20 °C, substrates / enzymes / molecules have less (kinetic) energy

(i) 1.08 (arbitrary units)

   at 80 °C, enzyme / amylase has denatured
   
   allow description of denaturation
   
   do not allow enzyme is killed

   so starch is not broken down (at all)
   
   allow the concentration of starch is still 0.5%

(a) glucose is absorbed by diffusion into the bloodstream

   then blood delivers glucose to muscles in capillaries

(b) to stop air getting in

(c) yellow

(d) collect the CO₂ / gas with a measuring cylinder / gas syringe

   (volume collected) in a certain time using a timer / watch

(e) yeast produces ethanol but muscles produce lactic acid

   marks can be awarded from correct word or balanced symbol equations

   yeast produces CO₂ but muscles do not

   answers must be comparative

   both release small amounts of energy

   ignore both occur without oxygen

[9]