

M1.(a) (Scientists) used fully grown leaves / used five plants of each (species).

Ignore other references to methodology. Reward only information provided in the Resource.

Do not accept reference to number of leaves – different plants were used.

1

(b) Either

1. Draw around leaf on graph paper;

Mark as a trio – MP1, MP2 and MP3 OR MP4, MP5 and MP6. Do not mix and match.

Both aspects needed for mark – drawing and type of paper.

2. Count squares (however described);

There is no reward for additional detail e.g. dealing with part squares.

3. Multiply by 2 (for upper and lower leaf surface);

OR

4. Draw around a leaf on paper of known mass (per unit area);

Both aspects needed for mark – drawing and mass of paper.

5. Cut out *and* weigh;

6. Multiply by 2 (for upper and lower leaf surface).

3

(c) (i) Species **B** (no mark)

1. Smaller surface area

so

less evaporation / less heat absorbed;

Correctly selected feature and the explanation required for 1 mark.

In all marking points – ‘less water loss’ is insufficient as an explanation but accept transpiration for evaporation or diffusion.

2. Thicker leaves

so

greater diffusion distance (for water);

Accept ‘thicker leaves so more water storage’.

3. Fewer stomata / lower stomatal density

so

less diffusion / evaporation (of water);

4. Smaller surface area to volume ratio
so
less evaporation.

1 max

- (ii) 1. Thick(er) cuticle
so
increase in diffusion
distance / slower (rate of) diffusion;
Feature and explanation needed for each mark.
Reject other features not related to leaves.
Reject features related to water storage.
'Cuticle' alone is insufficient (all leaves have a cuticle).
Reject suggestion of 'less' diffusion, for idea of 'slower diffusion', an idea of rate is required.
2. Hairs on leaves
so
reduction in air movements / increase in humidity / decrease in water potential gradient;
3. Curled leaves
so
reduction in air movements / increase in humidity / decrease in water potential gradient;
4. Sunken stomata
so
reduction in air movements / increase in humidity / decrease in water potential gradient.

2 max

- (d) Small leaves / surface area so (total) number of stomata is low.
Both aspects needed for mark.

1

[8]

- M2.(a)** 1. (No grease)
means stomata are open
OR
allows normal CO₂ uptake;
Allow 'gas exchange' for CO₂ uptake.

'As a control' is insufficient on its own.

2. (Grease on lower surface)
seals stomata
OR
stops CO₂ uptake through stomata
OR
to find CO₂ uptake through stomata
OR
shows CO₂ uptake through cuticle / upper surface;
3. (Grease on both surfaces) shows sealing is effective
OR
stops all CO₂ uptake.

3

- (b) (i) 1. (Mean rate of) carbon dioxide uptake was constant *and* fell after the light turned off;
Ignore absence of arbitrary units in both marking points.
Both ideas needed for mark.
Accept 'stayed at 4.5' as equivalent to 'was constant'.
2. Uptake fell from 4.5 to 0 / uptake started to fall at 60 minutes and reached lowest at 80 minutes / uptake fell over period of 20 minutes;
One correct use of figures required.
Accept fell to nothing / no uptake for 0.

2

- (ii) 1. (Because) water is lost through stomata;
2. (Closure) prevents / reduces water loss;
3. Maintain water content of cells.
This marking point rewards an understanding of reducing water loss e.g. reduce wilting, maintain turgor, and is not related to photosynthesis.

2 max

- (c) (i) (Carbon dioxide uptake) through the upper surface of the leaf / through cuticle.

1

- (ii) 1. No use of carbon dioxide in photosynthesis (in the dark);
 2. No diffusion gradient (maintained) for carbon dioxide into leaf / there is now a diffusion gradient for carbon dioxide out of leaf (due to respiration).

2

[10]

- M3.(a)** 1. Other gases / nitrogen / water vapour in atmosphere / **A**;
 2. Only oxygen and carbon dioxide in gas mixtures / **C** and **D**;
 3. Composition of / gases in **A** not controlled / composition of gas mixtures / **C** and **D** controlled.

2 max

- (b) 1. Breathing rate *lowest* when no carbon dioxide / in (pure) oxygen / **B**;
Idea of 'lowest' must be stated.
2. (Generally) presence of carbon dioxide increases breathing rate / as concentration of carbon dioxide increases breathing rate increases / there is a positive correlation;
A general point incorporating all concentrations.
3. Breathing rate increases when (carbon dioxide) higher than 0.1% / concentration in atmosphere / **A**;
This MP requires a specific comparison to 0.1% or the atmospheric concentration.
Accept 'gas mixtures 1 and 2 / C and D' for 'higher carbon dioxide'.
4. Breathing rate of **grasshopper 3** falls in **D** / 16% / gas mixture 2 (whereas others increase).
Restating data alone is insufficient for any mark point.

3 max

- (c) (i) 54;
OR
1. Correct data / column **A** chosen;
A correct answer of 54 gets 2 marks.
MP1 and MP2 allow a possible mark for an incorrect calculation or choice of wrong data.
2. Correct calculation of mean from data chosen;
Check – the three values must be from same column.

2 max

- (ii) 1. Small sample / only 3 (grasshoppers)
so may not be representative (of all grasshoppers / insects);
2. Grasshoppers are not the only insects / species;
so genetic / behavioural / metabolic differences;
3. (Insects) not all mature / are at different stages of development /
different sizes;
so different metabolic rates;
4. Movement not restricted / not at rest in meadow;
so (rate of) respiration higher;
5. (Naturally-occurring) carbon dioxide concentration lower in
meadow;
so breathing rate lower;

*Explanations required, therefore both parts of answer
required for credit in each marking point.*

Accept appropriate converse answers.

Accept 'respiration' for 'metabolism' and vice versa.

3 max

[10]

- M4.(a)** Fish keep moving / swimming / movement of gill covers too fast to count (at higher temperatures).

Accept converse.

Reject personal errors e.g. with counting.

Neutral – 'water not clear' or 'difficult to see movement of gill covers'.

1

- (b) 1. There is only one dependent variable / there are not two dependent variables / water temperature is the independent variable / breathing rate is dependent on water temperature;

Accept either approach for 1 mark.

For 'independent' accept 'manipulated'.

Reject – 'need two continuous variables'.

2. Water temperature *plus* breathing rate are not both properties of fish
or
water temperature plus breathing rate are not both properties of water.

Accept reference to the 'two variables' (instead of water temperature plus breathing rate)

1 max

- (c) (i) As (water) temperature increases, oxygen (concentration / solubility) falls and ventilation rate increases.

MP requires all 3 aspects before credit is possible. The correct context is required for each aspect so

e.g. do not reward

'as oxygen concentration falls, water temperature increases'

or

'as temperature increases, ventilation rate increases and oxygen concentration falls'.

1

- (ii) 1. As concentration / solubility of oxygen falls less oxygen flows over gills / less oxygen enters gills / less oxygen enters fish;

For MP1 and MP2 accept converse.

Both aspects needed for mark.

2. (As a result) blood oxygen (concentration) falls / is lower;
3. An increase in ventilation rate increases / maintains the flow of oxygen / carbon dioxide across gills / into (or out of) fish;
Accept idea in relation to either gas or 'gas exchange'.
4. Maintains diffusion / concentration gradient(s) (in gills);
Gradient(s) relates to either / both gas(es).
5. To maintain oxygen supply to cells / tissues / organs / to maintain respiration.
Accept a named example of 'tissues' e.g. muscle.

3 max

[6]

- M5.(a)** 1. Contraction of internal intercostal muscles;
2. Relaxation of diaphragm muscles / of external intercostal muscles;
3. Causes decrease in volume of chest / thoracic cavity;
4. Air pushed down pressure gradient.

4

- (b) 19(%)

1

- (c) 1. Muscle walls of bronchi / bronchioles contract;
 2. Walls of bronchi / bronchioles secrete more mucus;
 3. Diameter of airways reduced;
 4. (Therefore) flow of air reduced.

4

[9]

- M6.(a)** 1. Trachea and bronchi and bronchioles;
 2. Down pressure gradient;
 3. Down diffusion gradient;
 4. Across alveolar epithelium.
 Capillary wall neutral
 5. Across capillary endothelium / epithelium.

4 max

- (b) (About) 80.0%.

1

- (c) 1. (Group **B** because) breathe out as quickly as healthy / have similar FEV to group **A**;
 2. So bronchioles not affected;
 3. FVC reduced / total volume breathed out reduced.
 Allow this marking point for group C

3

[8]

- M7.(a)** 1. Water and blood flow in opposite directions;
 Accept: diagram if clearly annotated
 2. Maintains concentration / diffusion gradient / equilibrium not reached / water always next to blood with a lower concentration of oxygen;
 Must have the idea of 'maintaining' or 'always' in reference to concentration / diffusion gradient
 Accept: constant concentration / diffusion gradient

3. Along whole / length of gill / lamellae;
Accept: gill plate / gill filament 3
- (b) 1. (Thicker lamellae so) greater / longer diffusion distance / pathway;
Q Neutral: 'thicker' diffusion pathway
2. (Lamellae fuse so) reduced surface area;
Accept: reduced SA:VOL 2
- (c) (i) Correct answer of **5.1** or **5.14(2857)** (dm³) = 2 marks;;
Allow 1 mark max for an answer of 5 if the correct answer of 5.1 or 5.14(2857) is not shown
- One mark for incorrect answers that show **36** or **0.4 × 90** or **90 ÷ 7**; 2
- (ii) 1. Increased metabolism / respiration / enzyme activity;
Accept: enzymes work more efficiently
2. Less oxygen (dissolved in water);
Neutral: references to increased kinetic energy (of water molecules) 1 max
- [8]**
- M8.(a)** (i) (Simple) diffusion;
Reject facilitated diffusion
Accept lipid diffusion 1
- (ii) 1. Thin walls / cells;
1. *'Short diffusion pathway' alone is an explanation not a description*
1. *Accept squamous epithelia / one cell thick*
2. (Total) surface area is large;

2. Ignore references to 'volume ratio'

2

- (b) 1. Loss of elasticity / elastic tissue / increase in scar tissue;
1. *Accept elastin*
2. Less recoil;

2

[5]