

3.2 ORGANISMS AND SUBSTANCE EXCHANGE – GAS EXCHANGE – MARK SCHEMES

Q1.

- (a) 1. Measure (each stoma) using eyepiece graticule;
2. Calibrate eyepiece graticule against stage micrometer / ruler / graph paper;
3. Take a number of measurements (to calculate a mean);
 2. *Accept micrometer slide*
 3. *Idea of enough readings for a reliable mean (min. 5)* 3
- (b) 1.48;
Accept 1.5 and 1.479
1 mark for PS3 = 7.1 (μm) and ABA = 4.8 (μm) 2
- (c) 1. (Causes less stomatal opening so) less transpiration;
OR
Less evaporation;
OR
Less water lost by diffusion;
2. (So more) water available for photosynthesis / metabolism / support;
OR
(So) less water needed from the (dry) soil;
 2. *Water conserved / retained is insufficient*
 2. *Ignore respiration* 2
- (d) (Closes the stomata so) fewer / no spores enter leaf; 1

[8]

Q2.

- (a) 1. Many lamellae / filaments so large surface area;
2. Thin (surface) so short diffusion pathway;
 1 & 2 must each have a feature and a consequence 2
- (b) 1. Water and blood flow in opposite directions;
 Allow diagram showing counter-flow
2. Blood always passing water with a higher oxygen concentration;
3. Diffusion gradient maintained throughout length (of gill)
OR
Diffusion occurs throughout length of gill
OR
If water and blood flowed in same direction equilibrium would be reached; 3

[5]

Q3.

- (a) 1. Kinesis;
Ignore any prefix
2. Movement is random / non-directional
OR
Insect is not moving towards a particular stimulus; 2
- (b) 1. Less respiration so less gas exchange;
2. (So) spiracles open less so less water loss; 2
- (c) Taxis;
Ignore any prefix 1
- (d) No (no mark), the insect does not move in circles;
Shows kinesis / results similar to **Figure 1**; 2
- (e) **For (max 1)**
1. The data show a positive correlation;
Must state this as the description is given in the stem.
2. Large sample / number of insects so valid / reliable / representative;
- Against (max 1)**
3. (however) there are overlaps in individual experiments at all humidities;
4. 70–90% humidity there is little / no change in movement / movement only increases after 76% humidity;
Accept any value in this range 2 max

[9]

Q4.

- (a) (Simple) diffusion;
Reject: facilitated diffusion. 1
- (b) 1. Thin/small **so** short diffusion pathway;
Reject: thin membrane/wall/cells.
2. Flat/long/small/thin **so** large surface area to volume ratio/surface area : volume;
Accept: small volume to surface area ratio. 2
- (c) 1. High/50% saturation (with oxygen) below (pO_2 of) 0.2 kPa;
Accept: fully saturated or above 50% saturation below 0.2kPa.
Accept: any number between 0.08 and 0.2 kPa
2. (Oxygen) for respiration; 2

- (d) 1. Water potential higher in worm
OR
 Lower water potential in seawater;
Accept: correct reference to water potential gradient if direction of water movement is given.
Accept: ψ for water potential.
2. Water leaves by osmosis (and worm dies);
Reject: worm/cells burst.

2

[7]

Q5.

- (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]

Q6.

- (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]

Q7.

- (a) (i) Spiracle;
Accept: Spiracles 1
- (ii) Tracheole/trachea;
Accept: Tracheoles/tracheae
Ignore: System 1
- (b) 1. Oxygen used in (aerobic) respiration;
2. (so) oxygen (concentration) gradient (established);
Accept description of gradient
Ignore: 'along gradient idea' unless direction is made clear
Ignore: movement through gas/water
Reject: gradient in wrong direction
3. (so) oxygen diffuses in; 2 and 3.
Accept: oxygen moves down a diffusion gradient for 2 marks 3
- (c) 1. Abdominal pumping/pressure in tubes linked to carbon dioxide release;
MP1 relates to description of link shown in graphs
2. (Abdominal) pumping raises pressure in body;
Needs idea of causation, not just description of correlation
3. Air/carbon dioxide pushed out of body /air/carbon dioxide moves down pressure gradient (to atmosphere);
Reject ref to concentration gradients/diffusion 3

[8]

Q8.

- (a) 1. Diaphragm moves up /becomes dome shaped;
2. Reduces volume of thorax / increase pressure in thorax;
Accept 'space' for volume, chest/lungs for thorax
3. Pressure in thorax **higher** than outside (air);
Accept chest/lungs 3
- (b) 1. FEV₁ of those who have stopped smoking increased after 1 year whereas the FEV₁ of smokers decreased;
Comparison required

2. (Between years 1 and 5, FEV₁ of both decreases but) the rate of decrease in FEV₁ of smokers is faster than those who stopped smoking;

Idea of a faster rate of decrease in smokers, not just quoting final FEV values

2

- (c) 1. Airways are narrowed/blocked;
2. Excess mucus (in airway);
3. Inflammation (of airways);
4. Elasticity is lost/scar tissue builds up;

Ignore answers in the context of reduced surface area of alveoli or increased diffusion distance

2 max

[7]

Q9.

- (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]

Q10.

- (a)
1. Large sample size;
Accept: 20 + as equal to large sample size.
 2. Individuals chosen at random;
 3. Are healthy;
 4. Equal number of males and females;
Accept: same sex/gender.
 5. Repeat readings;
- (b)
1. (For) comparison;
Accept: provides a benchmark/standard.
 2. To see effect of age/emphysema/smoking
OR
Takes into account outliers/anomalous results;

2 max

- (c) Internal intercostal muscle(s) less effective
OR
 Less elasticity (of lung tissue);
Accept: different descriptions of less effective.
Recoil without reference to elasticity is insufficient.
Accept: 'less elastin'.

1

- (d) 1. Less carbon dioxide removed;
Accept: carbon dioxide increases/high (in body/blood).
1 and 2. Accept: 'low amount' as equivalent to 'less'.
 2. Less oxygen (uptake/in blood);
Accept: less oxygen inhaled.
2 and 3. Accept: less oxygen for respiration = 2 marks.
 3. Less (aerobic) respiration/ATP
OR
 (More) anaerobic respiration;
Accept: (more) lactic acid.

3

[8]

Q11.

- (a) 1. Line graph with rate on y axis and temperature on x axis and linear scales;
 2. Values calculated to appropriate sf;
 3. Rates correctly calculated and plotted, with ruled line connecting points and no extrapolation;
- (b) 8 or 9;
- (c) 1. Determine the area under the curve;
- (d) 1. Enzymes / metabolism faster;
 2. Higher rate of respiration and carbon dioxide production / release;
 3. Spiracles open more often / remain open to excrete / get rid of carbon dioxide / get more oxygen;
Note – explanation required

3

1

1

3

[8]

Q12.

- (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.
- (b) 19(%)
- (c) 1. Muscle walls of bronchi / bronchioles contract;

4

1

2. Walls of bronchi / bronchioles secrete more mucus;
3. Diameter of airways reduced;
4. (Therefore) flow of air reduced.

4

[9]

Q13.

- (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]

Q14.

- (a) Correct answer of $342.8 - 343 = 2$ marks;;

Credit incorrect answers that show the numerator as 144 (or $186-42$) or denominator as 42 for 1 mark;

2

- (b) 1. More air / oxygen enters / air / oxygen enters quickly / quicker;

1. Accept: converse for carbon dioxide

1. Can be in any correct context eg insect, tracheoles, muscle

1. Neutral: air / oxygen enters

(So) maintains / greater diffusion or concentration gradient;

2

- (c) Large(r) SA:VOL / short(er) diffusion distance (to tissues);

Accept: thin diffusion pathway

1

- (d) $6 / 6.6 / 6.7 / 7 / 7.5 / 8 = 2$ marks;;

Different answers given for different interpretations of the graph

Award 1 mark for incorrect answers that have divided 60 by any number;

2

- (e) Less / no water lost / (more) water retained;

Accept: less dehydration / less evaporation

Q Reject: less 'transpiration'

- (f) 1. Greater surface area exposed to air;
Neutral: shorter diffusion distance
2. Gases move / diffuse faster in air than through water;
2. **Q Neutral: 'harder to diffuse'**
2. *Accept gases diffuse directly, rather than through water*
3. Increases volume / amount of air;

1 max

[9]

Q15.

FOR

1. (If the husband smokes) there's a greater risk of dying from lung cancer / emphysema / cervical cancer;
2. The more the husband smokes, the greater the risk of dying from lung cancer / emphysema;
3. Suitable use of figures from the table to illustrate answer;

AGAINST

4. Little difference in risk of dying of stomach / heart disease;
5. Other factor (than husband smoking) / named factor might cause death;
6. Only one sample / further studies needed;

4 max

[4]

Q16.

- (a) 1. Protein synthesis **and** cell wall synthesis **and** cell expansion stop at -0.7 / at a *higher* water potential than other two;
If all 3 are correctly identified in marking point 1, accept 'the others / the other two' in marking point 2, and vice versa
2. Photosynthesis **and** stomatal opening stop at -1.5 / at a *lower* water potential than other three;
Correct processes must be named in at least one of marking point 1 or marking point 2
Where reference to water potential differences are made, they must be comparative, eg 'higher'

2

- (b) 1. Stomata allow uptake of carbon dioxide;
2. Carbon dioxide used in / required for photosynthesis;

2

- (c) 1. Growth involves cell division / cell expansion / increase in mass;
Marking point 1 is for the principle

2. Protein synthesis stops **so** no enzymes / no membrane proteins / no named protein (for growth / division);
Marking points 2, 3 and 4 require appreciation of 'why' before credit can be awarded
'named' protein must relate to proteins involved in growth or cell division
3. Cell wall synthesis stops **so** no new cells can be made;
Full credit is possible without a statement of the principle (marking point 1)
4. No cell expansion / increase in mass **because** (cells) stop taking up water;

3 max

[7]

Q17.

- (a)
1. Tracheoles have thin walls **so** short diffusion distance to cells;
 2. Highly branched / large number of tracheoles **so** short diffusion distance to cells;
 3. Highly branched / large number of tracheoles **so** large surface area (for gas exchange);
 4. Tracheae provide tubes full of air **so** fast diffusion (into insect tissues);
 5. Fluid in the end of the tracheoles that moves out (into tissues) during exercise **so** faster diffusion through the air to the gas exchange surface;

OR

Fluid in the end of the tracheoles that moves out (into tissues) during exercise **so** larger surface area (for gas exchange);

6. Body can be moved (by muscles) to move air **so** maintains diffusion / concentration gradient for oxygen / carbon dioxide;

1. *Do not accept unqualified references to thin membranes.*

Max 2 if any reference to blood

Ignore references to spiracles

5. *Accept 'water' for fluid.*

Accept 'cells' and 'tissues' as interchangeable words.

3 max

- (b)
1. Damselfly larvae has high(er) metabolic / respiratory (rate);
 2. (So) uses more oxygen (per unit time / per unit mass);

Idea of 'more / high' is needed for both mark points.

2. *Accept 'needs' for 'uses'*

2. *Ignore references to absorbing / obtaining / uptake of more oxygen*

2

- (c) Mean SA = $9.85 \text{ mm}^2 / 9.9 \text{ mm}^2$;
 Percentage uncertainty of SA = 18.5 / 18.7 / 19;

If both answers incorrect 1 mark for

Percentage uncertainty of dimensions 11.8 / 12 and 6.70 / 6.7

Surface area correctly calculated with correct units but not rounded to appropriate sf (9.8532 mm^2)

Surface area correct (with appropriate sf) but no / incorrect unit given

Both answers correct = 3 marks

1 answer correct only = 2

Both answers incorrect = max 1

3 max

- (d)
1. Don't use shading;
 2. Only use single lines / don't use sketching (lines) / ensure lines are continuous / connected;
 3. Add further labels / annotations;
 4. Don't cross label lines;
 5. Add magnification / scale (bar);

Reject 'colour in'.

Reject 'use of electron microscopes'

Ignore 'use a sharp pencil'

2 max

[10]

Q18.

- (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]

Q19.

- (a) up and out;

1

- (b) (i) does not require work / effort / involve muscle contraction / energy expenditure;

1

- (ii) active as it involves contraction of muscles;

1

- (c) liver moves back;
increases volume of lungs;
pressure lower (in lungs than outside);

3 max

- (d) *maximum of three marks for description, points 1 to 4*

- 1 inhaled air contains more oxygen than exhaled air;

- 2 inhaled air contains less carbon dioxide than exhaled air;
- 3 inhaled air contains less water (vapour);
- 4 relative amount / percentage of nitrogen also changes;
- 5 respiration results in lower blood oxygen / higher blood carbon dioxide;
- 6 oxygen enters blood / carbon dioxide leaves blood in alveoli;
- 7 by diffusion;
- 8 water vapour diffuses from moist surface;

6 max

[12]

Q20.

- (a) (i) Through alveolar epithelium;
 Through capillary epithelium / endothelium;
Accept: Through lining / wall of alveolus and capillary for 1 mark
Accept: squamous epithelial cells for 'epithelium'
Neutral: alveolar endothelium
Neutral: references to diffusion
Q Correct use of terminology; 2
- (ii) (Thicker alveolar wall) – no mark
Neutral: less diffusion
 (So) Longer diffusion pathway / slower diffusion;
Neutral: references to surface area 1
- (b) (i) (In alveolus)
Need the idea of air moving and oxygen concentration
 Brings in air containing a high(er) oxygen concentration;
Neutral: reference to carbon dioxide concentration
 Removes air with a low(er) oxygen concentration; 2
- (ii) Circulation of blood / moving blood;
Neutral: blood Neutral: short diffusion pathway 1
- (c) Long time between decrease in mining and increase in cases;
 Graph shows fluctuations;
 Correlation does not prove causation / there may be other causes of miner's lung;
 Improved diagnosis methods;
 Do not know number of cases / baseline before 1990;

Not all cases reported / not all individuals with miner's lung visit a doctor;
Accept: correct use of figures from graph for the first marking point: e.g. cases do not increase until after 2000 / 2001-2004 / 10 years later.

2 max

[8]

Q21.

- (a) Filaments / lamellae provide large surface area;

Thin / flattened epithelium / one / two cell layers so short diffusion pathway (between water and blood);

Countercurrent / blood flow maintains concentration / diffusion gradient;

Q Do not credit thin cell walls / membranes

2 max

- (b) (i) Large / wide range of values (so can fit on graph);

1

(ii) Decrease in uptake with increase in mass / negative correlation;

1

(iii) Enables comparison;

As animals differ in size / mass;

2

[6]

Q22.

- (a) 1. Large surface area provided by lamellae / filaments increases diffusion / makes diffusion efficient;;

*Q Candidates are required to refer to lamellae or filaments.
Do not penalise for confusion between two*

2. Thin epithelium / distance between water and blood;

3. Water and blood flow in opposite directions / countercurrent;

4. (Point 4) maintains concentration gradient (along gill) / equilibrium not reached / as water always next to blood with lower concentration of oxygen;

5. Circulation replaces blood saturated with oxygen;

6. Ventilation replaces water (as oxygen removed);

6

- (b) Mixing of air and water (at surface);

Air has higher concentration of oxygen than water;

Diffusion into water;

Plants / seaweeds near surface / in light;

Produce oxygen by photosynthesis;

2 max

(c) Not much oxygen near sea bed;
Toadfish haemoglobin (nearly) saturated / loads readily at / has higher affinity for oxygen at low partial pressure (of oxygen);

2

(d) The chimpanzee and the bonobo are more closely related (than to the gorilla);
They have identical amino acids / one of the amino acids is different in the gorilla;

2

[12]

Q23.

(a) Phagocytes engulf / ingest pathogens / microorganisms / bacteria / viruses;
Phagocytes destroy pathogens / microorganisms / bacteria / viruses;
Lung diseases are caused by pathogens / microorganisms / bacteria / viruses;
Q Allow description of process of engulfing

2 max

(b) (i) Alveoli / lungs will not inflate / deflate fully / reduced lung capacity;
Breathing out particularly affected / no longer passive;

2

(ii) Alveolar walls thicken;
Longer diffusion pathway;
Scarred / fibrous tissue;

Reduces surface area (for gaseous exchange);

Q Diffusion is essential for 2nd point and surface area for 4th point.

4

(c) (i) Cancer develops 20 – 30 years after exposure (to asbestos);

1

(ii) Smoking / air pollution / specified industrial source;

1

[10]

Q24.

(a) 1. Haemoglobin carries oxygen / has a high affinity for oxygen / oxyhaemoglobin;
2. Loading / uptake / association in lungs;
3. at high p.O₂;
4. Unloads / dissociates / releases to respiring cells / tissues;
5. at low p.O₂;
6. Unloading linked to higher carbon dioxide (concentration);
6. Ignore reference to incorrect pH in relation to effect of

- (b) 1. Allows comparison;
Do not credit 'temperature affects results' on its own;
2. (Different temperature) affects enzymes;
2. Allow reference to denaturation of enzymes.
3. (Different temperature) affects respiration / metabolism;
4. (Different temperature) affects amount of dissolved oxygen;
- 2 max
- (c) 1. Increases then levels out / stops increasing / fluctuates slightly;
2. At 5 (cm³ dm⁻³) / 320 (cm³ g⁻¹h⁻¹);
Allow description of 'fluctuates slightly' in terms of candidate quoting figures after 320.
- 2
- (d) 1. *Chronimus longistylus* has higher uptake at low (oxygen) concentrations;
Chronimus longistylus has higher uptake to (oxygen concentration of) 2 / lower uptake after 2; (= 2 marks)
2. (Higher uptake) up to 2 cm³ dm⁻³;
2. Award mark if candidate uses figures from table e.g. higher at concentration 1 (220) or concentration 2 (285). Higher uptake at concentration 1 or 2 = 2 marks.
- 2
- (e) (i) More (than in African) lost via gills in Australian lungfish / less (than African) lost via lungs in Australian lungfish;
- 1
- (ii) 1. More / most exchange is via lungs (in African lungfish);
1. Allow converse for first point.
2. Gills will not function / function less efficiently (in air);
2. Allow water is required for gills to function.
- 2

[15]

Q25.

- (a) 1. (Simple / facilitated) diffusion from high to low concentration / down concentration gradient;
Q Do not allow across / along / with concentration gradient
2. Small / non-polar / lipid-soluble molecules pass via phospholipids / bilayer;
Reject: named molecule passing through membrane by an incorrect route
Accept: diagrams if annotated

OR

Large / polar / water-soluble molecules go through proteins;

3. Water moves by osmosis / from high water potential to low water potential / from less to more negative water potential;
4. Active transport is movement from low to high concentration / against concentration gradient;
*Only penalise once if active transport is not named
e.g. 'movement against the concentration gradient involves proteins and requires ATP' = 2 marks*
5. Active transport / facilitated diffusion involves proteins / carriers;
*Accept: facilitated diffusion involves channels
Reject: active transport involves channels*
6. Active transport requires energy / ATP;
7. Ref. to Na⁺ / glucose co-transport;
Credit ref. to endo / exocytosis as an alternative

5 max

- (b)
1. Many alveoli / alveoli walls folded provide a large surface area;
Neutral: alveoli provide a large surface area
 2. Many capillaries provide a large surface area;
 3. (So) fast diffusion;
*Neutral: greater / better diffusion
Neutral: fast gas exchange
Allow 'fast diffusion' only once*
 4. Alveoli or capillary walls / epithelium / lining are thin / short distance between alveoli and blood;
*Reject: thin membranes / cell walls
Accept: one cell thick for 'thin'*
 5. Flattened / squamous epithelium;
Accept: endothelial
 6. (So) short diffusion distance / pathway;
 7. (So) fast diffusion;
 8. Ventilation / circulation;
Accept: descriptions for ventilation / circulation
 9. Maintains a diffusion / concentration gradient;
 10. (So) fast diffusion;
*Do not double penalise if description lacks detail
e.g. thin membranes so a short diffusion distance = 1 mark*

5 max

[10]

Q26.

- (i) (Lung volume) increases / reaches a maximum (at **B**);
Do not negate mark for 'breathing out' if qualified e.g. when (lung volume) decreases

(ii) Flattens / lowers / moves down;

(Diaphragm / muscle) contracts;

Reject: second mark only if intercostal muscles cause the diaphragm to flatten

2

[3]

Q27.

(a) Something that increases chance / increases probability / makes it more likely;

1

(b) (i) 1976 - / to / and 1980;

1

(ii) 1980 - / to / and 1996;

1

(c) 1. Correlation does not mean that there is a causal relationship;

1. Do not accept casual

2. May be some other factor / named factor associated with vehicles and asthma / producing rise in both;

3. (After 1980) asthma continues to rise but exhaust concentration falls / negative correlation (after 1980);

3

[6]

Q28.

(a) 1. Random;

Random number generator = 2 marks

2. Method e.g. number generator / number out of a hat;

Same age = 2 marks

OR

3. Matched / all the same;

4. For e.g. age / sex;

2 max

(b) 1. (Differences) are real / significant / not due to chance;

It = the difference

2. (As) bars / SDs do not overlap;

2. Accept: 'standard errors do not overlap' as told 'standard deviation' in the question stem

2

(c) 1. No / slight (placebo) effect;

2. Group 2 and 3 results are similar / the same / SDs / bars overlap;

2. Accept: other descriptions of Groups 2 and 3

2. Accept: that Groups 2 and 3 are not significantly different

2

- (d) 1. (Allows) anomalies to be identified / ignored / effect of anomalies to be reduced / effect of variation in data to be minimised / concordant results;
Accept: 'outliers' instead of anomalies
 1. *Reject: idea of not recording anomalies / preventing anomalies from occurring*
 1. *Accept: 'cancels out anomalies' as bottom line response*
2. (Makes) average / mean (more) reliable;
 2. *Q Neutral: makes the average / mean more accurate*
 2. *Ignore: 'more reliable' alone* 2
- (e) (i) 1. Unethical / unfair not to treat patients;
 2. Dangerous / could cause an asthma attack; 1 max
- (ii) 1. Ensures normal treatment does not affect results / improvements are only due to the spray;
 2. (As) normal treatment is short-lived / effective for less than 24 hours / (24h) is long enough for normal treatment to wear off; 2
- (f) (i) 1. (Improvement scores) are qualitative / subjective / rely on own judgement / different patients may assess symptoms differently;
Accept: converse arguments for measuring FEV₁ e.g. quantitative / objective patients cannot lie
 2. Some patients may lie / exaggerate / want to please doctors;
 1. *Neutral: empirical evidence* 2
- (ii) 1. Not blind / patients knew they were not receiving treatment / patients did not receive treatment;
 2. (So) more likely to underestimate / give lower scores / did not expect to improve / less improvement; 2

[15]

Q29.

- (a) 1. (Diaphragm / diaphragm muscle) relaxes / relaxed;
Ignore references to inhalation, intercostal muscles or ribs if given as additional information.
2. Domed shape / (diaphragm) moves up;
3. Increases pressure and decreases volume; 3
- (b) 1. Extend / extrapolate curve / graph;
2. (Read off where) it flattens / reaches maximum / peaks; 2
- (c) 1. (Without inhaler) narrower bronchioles / bronchioles not dilated as muscle (surrounding bronchioles) contracted;

Assume answer relates to Curve A, unless otherwise stated.

2. Less air able to pass through / more difficult for air to pass through;

2

[7]

Q30.

- (a) 1. Flatten / moves down;

1. Ignore: additional information about rib movements

2. (Diaphragm muscle) contracts;

2

- (b) 1. Diaphragm contracts / moves down / flattens;

Ignore refs to rib movement

2. Increases volume (of thorax) and decrease in pressure;

2. Accept pressure lower than atmospheric pressure

3. Air moves from high to lower pressure / down pressure gradient;

3. Reject: by diffusion

3

- (c) 1. Diffusion;

Accept down diffusion gradient

2. Across (alveoli) epithelium / (capillary) endothelium;

2. Accept: capillary epithelium / squamous cell

2 max

[7]

Q31.

- (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]

Q32.

- (a) (i) Diffusion;

Ignore references to structures, membrane components etc

Allow simple diffusion

Reject facilitated diffusion

1

- (ii) 1. (Thin / flat body) so short distance for diffusion / short diffusion pathway;

Ignore references to membrane, wall, body surface

2. (Thin / flat body so) large surface area to volume ratio;
'It' refers to flatworm's body

2

- (b) (i) A group of tissues;

Ignore references to function Group = more than one

1

- (ii) 1. (Carbon dioxide enters) via stomata;

Reject stroma

2. (Stomata opened by) guard cells;

3. Diffuses through air spaces;
Allow concentration gradient. Reject along gradient unless direction made clear
4. Down diffusion gradient;

3 max

[7]

Q33.

- (a) Stomata per mm² or cm²

OR

Number per mm² or cm²;

Accept: mm⁻² or cm⁻².

Reject: per μm² or μm⁻².

Reject: the use of a solidus / as being equivalent to per.

Ignore: 'amount'.

1

- (b) 1. Single/few layer(s) of cells;

Accept: more/too many/overlapping.

*'Single layer' without reference to cells/tissue should **not** be credited.*

2. So light can pass through;

2

- (c) 1. Distribution may not be uniform

OR

So it is a representative sample;

Accept: more/fewer stomata in different areas.

Ignore: anomalies/random/bias.

2. To obtain a (reliable) mean;

Accept: 'average'.

2

- (d) 1. Hairs **so** 'trap' water vapour and water potential gradient decreased;

2. Stomata in pits/grooves **so** 'trap' water vapour and water potential gradient decreased;

3. Thick (cuticle/waxy) layer **so** increases diffusion distance;

4. Waxy layer/cuticle **so** reduces evaporation/transpiration.

5. Rolled/folded/curled leaves **so** 'trap' water vapour and water potential gradient decreased;

6. Spines/needles **so** reduces surface area to volume ratio;

*1, 2 and 5. Accept: humid/moist air as 'water vapour' but **not** water/moisture on its own.*

1, 2 and 5. Accept: diffusion gradient as equivalent to water potential gradient.

1, 2 and 5. Accept: less exposed to air as an alternative to water potential gradient.

*6. Accept: spines/needles **so** 'reduce area'.*

2 max

- (e) 1. Water used for support/turgidity;

2. Water used in photosynthesis;

3. Water used in hydrolysis;
4. Water produced during respiration;

2 max

[9]

Q34.

- (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
- (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
- (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**;
- (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)

3

2

2

1 max

[8]

Q35.

- (a) 1. The more recent the sample the greater the concentration;
Accept converse
This could be expressed by reference to time e.g. 'concentration has increased since 25 000 years ago
2. Increases most in last 5000 years / more or less constant / slight increase between 30 000 and 15 000 years ago;
- (b) 1. Variation in data / spread of data;
Reject references to range e.g. 'range of data'

2

2. Around the mean;
Both marks are possible in the context of using the data
- 2
- (c) 1. Yes as pine leaves not in organic matter of the same age;
2. No as organic matter would be the same age as the pine leaves;
Accept either approach
- 1 max
- (d) Can get more CO₂ for photosynthesis;
More CO₂ enters leaf is insufficient.
Accept light-independent (reaction) as equivalent
- 1
- (e) Any **three** from:
1. (Overall data show) negative correlation;
Do not allow description of correlation because in question stem
2. Little change in number of stomata in last 10 000 years;
3. Small sample size;
4. Only one species studied;
5. Other factors / named factor may have affected number of stomata;
6. Evidence does not support the conclusion between 30 000 and 25 000 years ago / between 5000 years ago and present day;
Accept reference to either one of these age ranges
7. Appropriate reference to standard deviations (in comparing means);
E.g. no overlap between 15 000 and 10 000 years ago
- 3 max
- (f) Any **three** from :
1. Thick cuticle;
2. Small leaves / low surface area;
Accept other ways of describing 'small', e.g. 'needle-like'
3. Hairy leaves;
4. Sunken stomata;
5. Rolled leaves;
- 3 max