

1. (a) Large surface area: volume ratio;
meet requirements by diffusion (over body surface); 2
- (b) Maintains a concentration gradient;
(allowing diffusion of oxygen) across width of gill; 2
- (c) Large surface area for diffusion / O₂ uptake / gaseous exchange;
short diffusion path;
highly vascularised / many blood capillaries for O₂ transport; max 2
- (d) Gas exchange surfaces are permeable (to small molecules);
higher concentration of water molecules inside animal than out /
ψ gradient;
water will diffuse outwards / evaporation; max 2
- (e) (i) 6.53 / 6.25 / 6.5; (2.61 × 2.5)
(ii) 0.28 / 0.275 / 0.3; (0.11 × 2.5)
Both answers correct – 2 marks
error in calculation but clearly shows answer
obtained by multiplying figures – 1 mark 2
- (f) **EITHER**
Reference to spiracles;
limits exposure of respiratory surface / can close spiracles;
OR
sunken spiracles / hair round spiracles;
trapping moist air;
OR
trachea cuticle lined;
only lose water through tracheoles;
OR
trachea / tracheoles inside;
limiting exposure of respiratory surface; max 4

- (g) (i) Partial pressure on oxygen in muscle falls more;
high / more carbon dioxide produced;
lowers PH;
increase in temperature;
percentage saturation of Hb falls / lowers affinity /
increase dissociation;
displaces curve to right / results in Bohr shift; max 4
- (ii) In absence of oxygen / low partial pressure of oxygen in tissues /
oxygen still used in respiration;
haemoglobin acts as an oxygen store;
releases (large amount of) oxygen when low level in tissues; max 2

[20]

2. (a) Waxy cuticle;
Prevents passage/evaporation of water;
OR
Hairs on surface (allow description);
Moist air trapped/reduces water potential gradient;
OR
Sunken “openings”;
Moist air trapped/reduces water potential gradient;
OR
Stomata/spiracles can close;
Reduces evaporation; max 4
- (b) Carbon dioxide in tracheae;
Therefore spiracles open;
allowing water vapour to escape; 3

[7]

3. Picks up oxygen more readily (in lungs) / greater affinity / idea of
more readily saturated;
Where O₂ is low;
Ignore ‘rate of loading / unloading’. 2

[2]

4. (a) Accurate description of ventilation by water flow;
(Oxygen) removal by bloodstream;
Description of / countercurrent flow of blood and water (at gills);
Accept labelled diagram, ignore ‘contraflow’, reject ‘multiplier’. 2

- (b) 4.0 seconds / s; *accept 2 x 2s* 1
 (Total) time when oxygen (concentration) was increasing /
 oxygen diffusing in;
 OR
 (Total) time when carbon dioxide (concentration) was decreasing /
 carbon dioxide diffusing out; 1 max [4]
5. (a) More work done / more energy / ATP required;
 To overcome greater buoyancy;
Look for idea of buoyancy, not term. 2
- (b) (i) Retains oxygen until the partial pressure is low / myoglobin
 has high affinity for oxygen;
 Partial pressure of oxygen late in dive low;
 Gives up oxygen (readily) at low partial pressures; 2 max
- (ii) Remains under water for long time;
 Unable to breathe while under water;
 Greater amount of myoglobin can release / provide more oxygen;
 More myoglobin, the darker the muscle; 3 max
- (c) (i) 0.267 hours or 16 minutes;; 2
 Error, but $30\ 00\ \text{cm}^3$ divided by 250 = 1 mark
- (ii) Heart rate slows;
 Less blood flowing to / from muscles / liver / gut / blood flow to
 body other than brain reduced by 90%;
 Large volume of blood compared with body mass;
 Greater concentration of haemoglobin;
 Less blood required to supply heart / to heart muscle; 2 max
Reject imprecise answers relating to 'organs' / 'the body'.
- (d) Less blood to muscles / heart muscle / skin; 1 [12]
6. (a) (i) Many, small/ branching tracheoles; 1
 (ii) Blood not involved in transport of respiratory gases in insects; 1

- (b) Correct answer (ignoring working) $600x = 2$ marks;;
 Answer correct for candidate's R = 1 mark;
 Candidate clearly derives answer by dividing measured diameter by actual
 size = 1 mark; 2
- (c) Higher concentration of oxygen at S than in muscle; 1
[Not just concentration gradient: direction of gradient must be clear] [5]
7. (a) (gills have) lamellae on filaments; 2
 lots of both;
- (b) (i) all 3 go up; *[Accept converse]* 1
 (ii) more oxygen can be supplied;
 for more respiration; *[Accept answer relating to CO₂]* 2 [5]
8. (a) It is a measure of the concentration of a gas (in a mixture of gases or a liquid); 1
 (b) 37-38% *[Accept 36 – 39]*
 (c) muscle contraction causes increased respiration;
 increased CO₂ production lowering blood pH;
 lactate released lowering blood pH;
 increased heat released therefore increased temperature;
 increased O₂ consumption lowering tissue PO₂; max 4
 (d) haemoglobin has a lower affinity for oxygen;
 more O₂;
 for respiration; max 2

- (e) **3.4 times = 2 marks**
 (incorrect answer in which candidate shows amount of oxygen removed at rest is 4.6 and amount removed during exercise is 15.8 = 1 mark) 2
- (f) Nearly all O₂ is transported by haemoglobin / v. little transported in plasma;
EITHER
 Haemoglobin is (nearly) fully saturated with O₂ at the alveoli both at rest and when exercising;
 Therefore no (very little) further increase is possible;
OR
 Haemoglobin is only 95% saturated with oxygen at the alveoli;
 Therefore enriching inspired /air with oxygen will raise this to 100%; 3
- (g) increased depth / rate / pulmonary ventilation;
 increase stroke volume/heart rate/Q increases blood flow rate;
 arterioles [*Accept* artery] supplying the muscles dilate / vasodilation / greater proportion of blood flow to the muscles; max 3
- [15]**
9. (a) $\frac{10}{20} \times \text{measurment} / \frac{1}{2} \times \text{measurement} ;$
 = 1.25 to 1.5;
allow 1 mark if correct working shown max 2
- (b) Maintains concentration gradient (over whole length of gill) / diffusion can occur over whole gill;
More oxygen enters blood (/ more CO₂ leaves);
More (aerobic) respiration / more energy release in muscle / for swimming;
'more' needed ONCE only 3
- [5]**
10. (a) increasing carbon dioxide concentration / partial pressure;
(decrease in oxygen negates) 1
- (b) (oxygen is used in) respiration;
 therefore diffuses (from tracheae) to tissues;
 oxygen unable to enter organism; 2 max
- (c) spiracles not open all the time;
 therefore there is less water loss
 (by diffusion through spiracles); 2
- [5]**

11. (a) (i) high/higher CO₂ concentration / lack of oxygen; 1
(ii) CO₂ asphyxiates / is toxic;
lack of oxygen for (aerobic) respiration;
lack of energy / ATP (for pumping movements);
reduced muscle function / muscle fatigue 2 max
- (b) removal of (excess) CO₂ / oxygen to break down lactate / to repay oxygen
debt/to enable aerobic respiration; 1

[4]

12. (a) dry conditions - stomata partially closed;
due to less turgor in guard cells; OR
watered conditions - stomata more open;
due to greater turgor in guard cells; 2

EITHER

- (b) (i) temperature [*Allow heat*] - higher causes more water evaporation /
diffusion [*not just transpiration*]
OR
light - causes stomatal opening
OR
soil texture - determines availability of water
OR
humidity - reduces evaporation / reduces gradient / wind causes more
(water) evaporation; 1
- (ii) high CO₂ gives less variation AND watering gives less variation;
OR insignificant difference in variability as small differences in SD;
reject 'no difference' 1

[4]

13. (a) (i) oxygen concentration in air / water constant / surface area /
thickness of skin constant; 1
(ii) skin more important in winter and lungs in summer; 1
- (b) (i) (winter) – low temp – skin takes up more oxygen;
(summer) – higher temp – lungs takes up more oxygen; 2
(ii) skin is more important in winter and summer / all the time
/ at all temperatures; 1

- (c) (i) (thin) – short diffusion pathway; 2
(hairs) – greater surface area for exchange;
- (ii) provides more (oxygenated) water over surface / maintains the concentration gradient; 1

[8]

14. (a) 1 Large surface area provided by lamellae/filaments;
Q Candidates are required to refer to lamellae or filaments. Do not penalise for confusion between two
- 2 Increases diffusion/makes diffusion efficient;
- 3 Thin epithelium/distance between water and blood;
- 4 Water and blood flow in opposite directions/countercurrent;
- 5 (Point 4) maintains concentration gradient (along gill)/equilibrium not reached;
5 Not enough to say gives steep concentration gradient
- 6 As water always next to blood with lower concentration of oxygen;
- 7 Circulation replaces blood saturated with oxygen;
- 8 Ventilation replaces water (as oxygen removed); 6 max
6-8 Accept answers relating to carbon dioxide
- (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) (i) 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

- (ii) (Chimpanzee) orang-utan;
Amino acids different so bases different;
Few hydrogen bonds;

3

[15]