

**QUESTIONSHEET 1**

- (a) Any five of:  
 suitable time for equilibration (10 mins)/  
 temperature control/water bath/  
 manometer levels equalised by syringe and taps closed/  
 allow to run suitable time/30 mins/for manometer level to move a specific distance/  
 fluid rises in left hand tube/  
 tube calibrated or use  $v = \pi r^2 h$  to calculate volume of oxygen used/  
 repeat to find mean values;;;;; **5**
- (b) (i) replace potassium hydroxide with water; **1**
- (ii) Any four of:  
 investigation run for same period of time as first investigation/  
 under same conditions/temperature/  
 volume change in tube due to net effect/  
 i.e. volume of carbon dioxide produced – volume of oxygen consumed/  
 volume of carbon dioxide produced = volume change in investigation – volume change in first investigation;;;;; **max 4**

**TOTAL 10****QUESTIONSHEET 2**

- (a) alveolar/expired lower than inspired due to diffusion of oxygen into blood;  
 bound onto haemoglobin and carried away so gradient maintained;  
 expired higher than alveolar because it mixes with residual inspired air in airways/dead space; **3**
- (b) total volume of expired air larger due to water vapour content increase/carbon dioxide content increase  
 /expansion due to warming;  
 lower percentage of nitrogen is actually the same amount as in inspired air but figures distorted by other changes; **2**
- (c) water evaporates into air from wet surfaces (of alveoli/airways); **1**
- (d) (i) soot/tar in alveoli reduce uptake of oxygen and release of carbon dioxide;  
 some carbon monoxide will be absorbed into blood; **2**
- (ii) level of oxygen in expired air would remain higher;  
 level of carbon dioxide in expired air would remain lower. **2**

**TOTAL 10**

**QUESTIONSHEET 3**

Feature	Mammal	Insect	
Walls of air ducts supported by skeletal material	✓	✓	;
Respiratory surfaces moist	✓	✓	;
Respiratory ducts partly lined with cilia	✓	×	;
Air passages reach directly into respiring cells	×	✓	;
Oxygen carried on a respiratory pigment in blood	✓	×	;
Volume of fluid in respiratory ducts varies in proportion to activity	×	✓	;

**TOTAL 6****QUESTIONSHEET 4**

- (a) A = tidal/resting volume; B = vital capacity; C = residual volume; **3**
- (b) (i) increase in depth (of breathing);  
increase in frequency (of breathing)/faster breathing; **2**
- (ii) hydrogen carbonate ions/dissolved CO<sub>2</sub>; **1**
- (iii) Any two of: carotid bodies/aortic bodies/medulla or brain stem;; **2**
- (c) (i) medulla/brain stem; **1**
- (ii) Any four of:  
external intercostal muscles contract/  
internal intercostal muscles relax/  
rib cage pulled upwards and forwards/  
diaphragm contracts flattening (from a dome shape)/  
enlargement of thoracic cavity causes negative pressure in (airtight) pleural cavity/  
thus (elastic) lungs inflate with reduced pressure and air is drawn in;;; **4**

**TOTAL 13**

**QUESTIONSHEET 5**

- (a) (i) to enable absorption of adequate quantities of oxygen/removal of carbon dioxide produced;  
to meet (metabolic) needs of the organism/so metabolism is not limited by oxygen supply/carbon dioxide removal; **2**
- (ii) surface area to volume ratio is larger in a small organism than a large one;  
use of figures, eg. SA:Vol in a 1cm cube = 6:1 but in a 2cm cube = 3:1 ;  
thus Amoeba, being microscopic/tiny can absorb enough oxygen through its surface, but larger organisms cannot;  
thus larger organisms increase the respiratory surface area by folding (into complex structures); **max 3**
- (iii) Any three of: moist/ thin/ good blood supply/efficient ventilation mechanism;;; **3**
- (b) (i) earthworm: the outer epidermis/body surface;  
insect: the tracheoles;  
fish: the gills;  
mammal: the alveoli; **4**
- (ii) many/millions of alveoli give large surface area;  
lined by thin pavement/simple squamous epithelium for short diffusion distance;  
moist with (tissue) fluid (reject mucus) to let oxygen dissolve;  
surrounded by dense capillary network/blood supply for efficient uptake of oxygen/removal of carbon dioxide;  
elastic to enable (dimension changes during) ventilation movements; **max 4**
- TOTAL 16**
- 

**QUESTIONSHEET 6**

- (a) (i) if A is large then J must be large and so more oxygen can be diffused; **1**
- (ii) if  $\Delta x$  is small then J must be large and so more oxygen can be diffused; **1**
- (iii) an efficient blood supply will carry oxygen away more efficiently;  
thus  $\Delta c$  will be large and so J will be large so more oxygen can be diffused; **2**
- (b) as Amoeba grows the distance for oxygen to diffuse from the (surrounding) water into the centre of the cell increases;  
this is  $\Delta x$  and if this is increased J is reduced;  
thus the central regions of the Amoeba cell become deprived of oxygen above a certain cell size;  
division reduces it to a more suitable size for efficient gas exchange; **max 3**
- (c) (i) A/surface area is increased by having millions of tracheoles/a tracheole to every cell;  
the insect carries out ventilation movements to increase  $\Delta c$ ; **2**
- (ii) A/surface area is increased by having thousands of gill filaments;  
 $\Delta x$  is reduced in size by having a thin epithelial (gill) lining;  
 $\Delta c$  is increased by having a very large blood supply/capillary network;  
 $\Delta c$  is increased by having an efficient ventilation mechanism to pass oxygen rich water over the gills;  
 $\Delta c$  is increased by having a counterflow of blood and water at the gills; **max 3**
- TOTAL 12**

**QUESTIONSHEET 7**

- (a) (i) A = trachea; B = bronchus; C = bronchiole; **3**
- (ii) A: has a C-shaped ring of cartilage;  
smooth muscle only between cartilage ends;  
epithelium is a ciliated (psuedostratified) columnar type;  
largest of the three ducts; **max 2**
- B: has cartilage plates (rather than a ring);  
has a ring of smooth/bronchial muscle;  
epithelium is a ciliated columnar type (lower than psuedostratified);  
smaller than A but bigger than C; **max 2**
- C: epithelium is not ciliated, low columnar or cuboidal type;  
lumen is star-shaped/stellate (allows for dilation)/no cartilage;  
shows parallel branches of pulmonary vessels;  
this is the smallest of the three ducts; **max 2**
- (b) (i) goblet cells secrete mucus (onto the surface);  
dust particles/bacteria stick to the mucus;  
cilia beat these particles up to the glottis/throat where they are swallowed;  
ref to disinfection by stomach acid;  
keeps bronchial tree clean/defence against infection; **max 3**
- (ii) keeps trachea/bronchi open during pressure changes of ventilation;  
when food is passing down (adjacent) oesophagus;  
ring structure enables trachea to be flexible so that neck can bend;  
provides attachment for smooth muscles (in trachea);  
ring structure allows trachea to lengthen and shorten during ventilation movements; **max 3**
- (iii) enables bronchi/bronchioles to dilate or constrict;  
thus giving fine adjustment of air flow;  
(in finer bronchioles) gives some elastic recoil after stretching (which helps to move air out);  
ref to asthma when the bronchial muscle constricts spasmodically (during exhalation); **max 3**

**TOTAL 18**

**QUESTIONSHEET 8**

- (a) (i) A = cuticle; B = upper epidermis; C = palisade mesophyll;  
D = air space; E = spongy mesophyll; F = guard cells;  
G = lower epidermis; H = stoma/stomatal pore; (Allow 'epidermis' if unqualified once) **8**
- (ii) most photosynthesis occurs in palisade mesophyll;  
requires a good supply of carbon dioxide from atmosphere;  
and surplus oxygen must be released to the atmosphere;  
high oxygen concentration in the leaf would inhibit RuBP carboxylase;  
ref to O<sub>2</sub>/CO<sub>2</sub> exchange for respiration;  
ref to water vapour loss maintaining transpiration stream; **max 4**
- (iii) huge number of spongy/palisade mesophyll cells provide a big surface area (for gas absorption);  
large number of air spaces in contact with spongy cells;  
covered in film of water (from xylem) to dissolve gases;  
mesophyll cells have thin cellulosic walls (which are permeable to gases); **max 3**
- (b) when guard cells are turgid they open the stoma/converse;  
shape changes due to unevenly thickened cell walls;  
guard cells contain chloroplasts so can photosynthesise in light/store starch;  
(thus) in light they make glucose/stored starch turned to glucose;  
this reduces the water potential of the guard cells;  
(thus) water enters making them turgid (and stoma opens);  
in dark no photosynthesis so less glucose present;  
(thus) water potential of guard cells rises, water leaves/become flaccid (and stoma closes); **max 5**

**TOTAL 20****QUESTIONSHEET 9**

- (a) (i) A = (branch of) pulmonary artery/pulmonary arteriole;  
B = (branch of) pulmonary vein/pulmonary venule; **2**
- (ii) serous fluid/tissue fluid/lymph; (reject 'mucus') **1**
- to dissolve gases/oxygen/carbon dioxide (enabling easier diffusion);  
contains surfactants to lower surface tension;  
which enables dimension changes during ventilation; **max 2**
- (iii) 1. lined by pavement /simple squamous epithelium;  
this is very thin to enable efficient diffusion;  
very large/profuse capillary network;  
to enable efficient uptake of oxygen/release of carbon dioxide/maintain diffusion gradients;  
little other tissue present which would impede diffusion; **max 3**
2. contains elastic fibres/elastic connective tissue;  
which enables dimension changes (due to ventilation);  
elastic recoil helps to push air out of alveoli; **max 2**
- (b) alveoli contain dust cells/macrophages;  
which engulf bacteria/dust particles;  
break them down;  
by lysosomal action;  
coughing; (but reject mucus and cilia in alveoli) **max 2**

**TOTAL 12**

**QUESTIONSHEET 10**

contracts;  
domed/arched;  
flat/flatter;

external intercostal;  
internal intercostal; } allow 1 mark for 'intercostal muscles' unqualified.

increases;  
negative/reduced/lower;  
pleural/thoracic;  
reducing;  
alveoli;  
bronchial;

external intercostal;  
internal intercostal; } allow 1 mark for 'intercostal muscles' unqualified.

**TOTAL 13****QUESTIONSHEET 11**

- (a) (i) A = epiglottis; B = trachea/windpipe; C = bronchus;  
D = bronchiole; E = pleural membranes; **5**
- (ii) to prevent food passing into larynx/trachea during swallowing; **1**
- (iii) (pleural membranes are) tough and strongly attached to chest wall and lungs;  
enclose air-tight pleural cavity;  
this has a negative pressure which keeps (elastic) lungs expanded (against chest wall);  
ensures that as thorax expands so will the lungs;  
covered with (serous/tissue) fluid so no friction during ventilation (movements); **max 3**
- (b) external intercostal muscles relax, internal intercostal muscles contract;  
thus rib cage falls inwards and down;  
diaphragm relaxes;  
diaphragm becomes domed;  
(thus) thoracic volume and (so) lung volume decreased;  
(thus) higher pressure in lungs forces air out (through respiratory passages);  
ref to elastic recoil in alveoli enhancing expulsion of air; **max 4**
- (c) (i) the volume inhaled/exhaled during a single quiet breath/resting breath; **1**
- (ii) the maximum volume of air that can be inhaled/exhaled in one breath;  
the sum of the forced expiratory capacity and the forced inspiratory capacity; (allow alternative terms if correct) **2**

**TOTAL 16**

**QUESTIONSHEET 12**

- (a) (i) pharynx; 1
- (ii) separates food from air flow/nasal chamber from mouth/buccal cavity/prevents food entering the nasal chamber; 1
- (iii) prevents food passing into larynx/trachea during swallowing/stops food going down the wrong way; 1
- (iv) when speaking the glottis/entry to the larynx must be open;  
to allow air passage over the vocal cords (in the larynx);  
thus food particles could easily pass into/be sucked into the larynx/trachea; max 2
- (b) warms the air (near to body temperature);  
by heat from (profuse) blood supply;
- cleans the air/traps dust/bacteria in (surface) layer of mucus;  
cilia moves this/polypi to nostrils for removal (by sneezing);
- concerned with sense of smell/olfaction;  
substances dissolve in moisture (on mucosa) and can then stimulate/depolarise receptors; 6
- TOTAL 11**
- 

**QUESTIONSHEET 13**

- (a) (i) dissolves in fluid (lining the alveolus);  
diffusion through membrane (to red cell);  
thin wall so short gradient;  
concentration gradient maintained by inspiration and blood flow;  
much oxygen loaded onto haemoglobin;  
which makes oxygen gradient even steeper; max 4
- (ii) ref hydrogen carbonate ions in red cell;  
converted to carbon dioxide by carbonic anhydrase/correct equation;  
dissolves in plasma and diffuses to alveolus;  
gradient maintained by blood flow and by expiration;  
ref to carbon dioxide released from carbaminohaemoglobin; max 4
- (b) (i) allows alveoli to expand/contract during ventilation movements;  
elastic recoil at end of expiration pushes some extra air out (of alveoli); 2
- (ii) reduces surface tension (allowing easier lung expansion); 1
- (c) if the walls become thickened  $\Delta x$  is increased and so  $J$ / the (net) rate of diffusion is reduced;  
if alveoli are lost then  $A$  is decreased and so  $J$ /the (net) rate of diffusion is reduced;  
with loss of elastic tissue the alveoli will not ventilate effectively/will not expand and contract;  
thus the concentration gradient/ $\Delta c$  will be reduced and so  $J$ /the (net) rate of diffusion will be reduced;  
if  $J$  is reduced far enough then inadequate gas exchange will occur; max 4
- TOTAL 15**

**QUESTIONSHEET 14**

(a)(i)

	Respiratory surface	Example of organism
A	cell surface;	protocistans/protozoa/any other eg;
B	body surface/wall;	annelid/earthworm/any other eg;
C	gill;	fishes/any other eg;
D	lung;	mammal/any other eg;
E	tracheal system/tracheoles;	insects/named example;

**10**

(ii) increase in respiratory surface area (relative to body surface area);

**1**

- (iii) A lives in water/aquatic environment/water films of soil;  
 B secretion from epidermal glands/leaked coelomic fluid;  
 C lives in water which washes over the surface;  
 D lined by a layer of serous/tissue fluid;  
 E end tracheoles are filled with tissue fluid;

**5**

(b) oxygen is not very soluble in water/solubility less as temperature rises;  
 the respiratory pigment will take up and carry huge quantities of oxygen;  
 sufficient to meet the organisms' needs in all activities/means oxygen availability is not limiting;  
 respiratory pigment will release oxygen easily in respiring tissues;  
 eg/haemoglobin/haemocyanin;

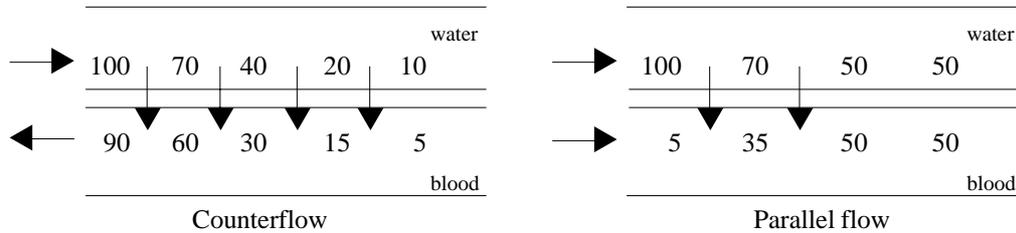
**max 3****TOTAL 19**

**QUESTIONSHEET 15**

- (a) makes a countercurrent exchange system;  
which enhances diffusion/uptake of oxygen/loss of carbon dioxide;  
figures to show improved gradient with counterflow/simple diagram;  
figures to show poor gradients with parallel flow/simple diagram;

**max 3**

Suggested drawings/figures:



- (b) stretch receptors are in the alveolar walls/walls of bronchial tubes;  
stimulated at end of inflation/when alveoli are expanded;  
impulses sent (along vagus nerve) to inspiratory centre/medulla/apneustic centre/respiratory centre ;  
inspiratory centre inhibited/expiratory centre stimulated;  
expiration occurs so stimulation of stretch receptors is stopped;

**max 4**

- (c) chemoreceptors in the aortic/carotid bodies/medulla of brain;  
sensitive to hydrogen ion concentration of blood;  
increase in carbon dioxide concentration of blood causes an increase in hydrogen ions;  
since  $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 \rightarrow \text{H}^+ + \text{HCO}_3^-$  /explanation in words;  
impulses sent to respiratory centre/medulla to increase ventilation/removal of carbon dioxide;

**max 4**

- (d) motor nerve;  
to diaphragm;  
arises from (cervical) spinal nerves/provides nerve pathway from spinal cord;  
carries impulses to cause contraction of diaphragm muscle fibres during inhalation;

**max 3****TOTAL 14****QUESTIONSHEET 16**

- (a) (i) 1. in the light when the stomata are open;  
2. in light intensities over the compensation point (when stomata are open);  
3. in light intensities below the compensation point (when stomata are open);
- (ii) in light chloroplasts make sugars/sucrose/glucose by photosynthesis;  
this raises solute concentration/potential of guard cells;  
thus water potential of guard cells falls below that of surrounding cells;  
thus guard cells absorb water and swell so opening/thickened walls cause opening;
- (b) potassium pump raises solute concentration/potential of guard cells;  
thus water potential of guard cells falls and water absorption occurs;  
(uneven) thickening of stomatal walls results in stomatal opening;  
this mechanism allows rapid opening (in light);

**3****max 3****max 3****TOTAL 9**

**QUESTIONSHEET 17**

- (a) (i) bacteria/viruses on membranes of bronchial passages/irritation;  
stimulate over production of mucus (which can cause obstruction);  
neutrophils/monocytes/phagocytes may also invade area of infection;  
causing build up of pus/infection debris (which can cause obstruction); **max 3**
- (ii) emphysema due to irritation due by pollutants/industrial dust/tobacco smoke;  
excessive coughing;  
over a long period of time;  
ref to genetic emphysema;  
due to alpha-1 trypsin deficiency; **max 3**
- (b) in obstructive type the air tubes will usually only be partly blocked and so air can be forced out although slower (than normal);  
in restrictive type the alveoli will not change dimensions (due to no elasticity) and so (virtually) no air can be forced out; **2**

**TOTAL 8**

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**QUESTIONSHEET 18**

- (a) the rate of metabolism (of the organism) when at rest/asleep/slowest normal rate of metabolism; **1**
- (b) measure the mass of the animal (in grammes);  
measure the volume of oxygen absorbed by the animal;  
express as  $\text{mm}^3\text{g}^{-1}\text{h}^{-1}$ ;  
use a respirometer/spirometer/whole body plethysmograph, depending on body mass;  
animal must be relaxed/at rest; **max 3**
- (c) smaller mammals have larger surface areas in proportion to their volume;  
therefore tend to lose heat more quickly (through skin);  
also breathe more quickly so tend to lose more heat via respiratory pathways;  
thus need higher rate of metabolism to compensate for greater heat loss; **max 3**
- (d) have a much faster rate of breathing/higher ventilation frequency/more breaths per minute;  
frequency of heart beat is much higher in small mammals/more beats per minute/higher relative cardiac output;  
may have a more efficient haemoglobin/dissociation curve of small mammal lies to the left of that of a large mammal; **max 2**

**TOTAL 9**

**QUESTIONSHEET 19**

- (a) external intercostal muscles contract;  
internal intercostal muscles relax; } allow 1 mark if say 'intercostal muscles contract'.  
this raises rib cage and sternum forwards and upwards;  
diaphragm (muscle) contracts so diaphragm flattens;  
thus thoracic volume is increased; **max 4**
- (b) 1. pleural cavity pressure less than lung pressure;  
this causes (elastic) lungs to expand;  
since pleural membranes are tightly bonded/stuck to chest wall and to lungs;  
lung pressure less than atmospheric pressure;  
thus air rushes in from atmosphere to balance pressures;  
(give credit if figures used rather than description) **max 4**
2. lung pressure higher than atmospheric pressure;  
thus air now forced out of lungs to atmosphere;  
pleural cavity pressure raised by pressure of chest wall moving down and in;  
(give credit if figures used rather than description) **max 2**
- (c) air would rush through hole into pleural cavity;  
until pressure reached atmospheric/ref pneumothorax;  
lung would no longer be kept inflated against chest wall/lung would collapse;  
due to presence of elastic tissue;  
lung would not ventilate;  
ref pleural cavities round each lung are separate so only one lung should be affected; **max 3**

**TOTAL 13****QUESTIONSHEET 20**

- (a) minute respiratory volume is the volume/dm<sup>3</sup> of air inspired per minute;  
measured (at rest) by tidal volume x number of breaths per minute;  
vital capacity is the total volume of air that can be inhaled/exhaled;  
sum of the inspiratory capacity and expiratory reserve volume/sum of the inspiratory reserve volume, tidal volume and expiratory reserve volume; **max 3**
- (b) tracheae are air filled tubes whereas tracheoles contain fluid;  
tracheae are supported by chitinous rings but tracheoles have no chitin support;  
tracheae run from spiracles to tracheoles, tracheoles run from tracheae to tissues/cells;  
tracheae are large/some visible with naked eye, tracheoles are microscopic; **max 3**
- (c) spiracles are breathing holes through insect cuticle, stomata are gas exchange holes on leaves;  
spiracles lead to tracheal system, stomata lead to air spaces of spongy mesophyll;  
spiracles open with inhalation movements (of insect), stomata continually open (in light);  
spiracles operate over 24 hours, stomata only operate in light;  
spiracles can close by muscular action (to cut down water loss), stomata are opened/closed by guard cells; **max 3**
- (d) gill filaments are attached to (bony) gill arches, gill lamellae make up gill filaments;  
each gill arch has two rows of gill filaments;  
gill filament consists of a stack of joined disc like lamellae;  
these contain a profuse/good capillary network and blood spaces for efficient gas exchange (between blood and water);  
ref blood water counterflow/huge surface area; **max 3**
- (e) spongy mesophyll has irregularly shaped/lobed/round cells/palisade cells are cylindrical;  
palisade cells contain many more chloroplasts than spongy cells;  
spongy cells have many large air spaces for gas exchange, palisade cells have few/small air spaces;  
spongy cells on ventral/underside of leaf near to stomata (for gas exchange),  
palisade cells are on dorsal/upper side nearest sunlight (for photosynthesis); **max 3**

**TOTAL 15**