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_2; **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 mucles contract/
internal intercostal mucles 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 Δx 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 Δc 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 Δx 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 Δc; **2**

(ii) A/surface area is increased by having thousands of gill filaments;
Δx is reduced in size by having a thin epithelial (gill) lining;
Δc is increased by having a very large blood supply/capillary network;
Δc is increased by having an efficient ventilation mechanism to pass oxygen rich water over the gills;
Δc 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_2/CO_2 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;
<u>much</u> 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 <u>carbamino</u>haemoglobin; **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 Δx 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/Δc 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;	protoctistans/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 enviroment/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**

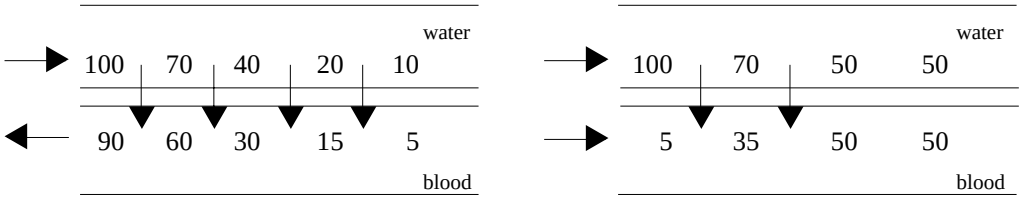
(b) oxygen is not very soluble in water/solubility less as temperature rises;
the respiratory pigment will take up and carry huge quantities of oxygen;
sufficient to meet the organisms' needs in all activities/means oxygen availability is not limiting;
respiratory pigment will release oxygen easily in 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 $CO_2 + H_2O \rightarrow H_2CO_3 \rightarrow H^+ + HCO^-_3$ /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); **3**

(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; **max 3**

(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); **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 emhysema;
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

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 $mm^3g^{-1}h^{-1}$;
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^3 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