Question			Expected Answers	Marks	Additional Guidance
1	(a)	(i)	**diaphragm** / **intercostal** muscles**,** contract **:**		*First two points are marked independently* **DO NOT CREDIT** *internal* intercostal muscles contract
			diaphragm moves down / ribs move upwards and outwards **;**		**DO NOT CREDIT** diaphragm flattens alone **ACCEPT** movement of diaphragm pushes digestive organs down
			volume of **thorax** increased **;**		**DO NOT ACCEPT** expands (for increased volume)
			pressure inside thorax falls **;**		**DO NOT ACCEPT** size for volume **ACCEPT** capacity for volume **ACCEPT** lungs / chest (cavity), for thorax
			to below atmospheric pressure (so air enters lungs) **;**		**DO NOT CREDIT** pressure gradient alone - *direction* of gradient must be specified
			2 max *for mechanism*		
			QWC: accept three technical terms used and spelt correctly **;**	**3 max**	accept any **three** from: diaphragm, intercostal, volume, pressure, thorax, thoracic cavity

Question			Expected Answers	Marks	Additional Guidance
1	(a)	(ii)	it falls / goes down / AW **;**	1	**ACCEPT** decreases in volume / volume gets smaller **DO NOT CREDIT** empties, closes, flattens, deflates, becomes smaller **DO NOT ACCEPT** amount for volume
1		(iii)	soda lime / sodium hydroxide / potassium hydroxide / calcium hydroxide **;**	1	**ACCEPT** correct formulae NaOH / KOH / $Ca(OH)_2$ **DO NOT ACCEPT** calcium oxide **ACCEPT** limewater, lime soda
1	(b)		to ensure all air breathed comes from chamber **OR** to prevent, escape of air / entry of air**,** through nose **;**	2 max	**ACCEPT** air may be breathed in or out through nose **ACCEPT** ensures breathes through mouth
			make results <u>invalid</u> **;**		**DO NOT ACCEPT** ref accuracy, reliability, false results **DO NOT ACCEPT** invalid **and** accuracy / reliability (use of **both** terms) anywhere in the answer

Marks			Expected Answers	Marks	Additional Guidance
1	(c)		use (medical grade) oxygen / fresh air **;**		*Note question relates to measuring **vital capacity*** **ACCEPT** ensure there is enough oxygen / air
			disinfect mouthpiece **;**		**ACCEPT** change / wash mouthpiece
			ref. to health of subject **;**		e. asthmatics
			ref to correct functioning of equipment **;**	**2 max**	e.g. maintain constant temperature (so that volume of gases is not affected) ensure, valve / hinge, is working level of water correct no leaks / airtight / lips sealed around mouthpiece
			Total	**9**	

Question			Expected Answers	Marks	Additional Guidance
2	(a)	(i)	goblet / mucus (secreting) cell **;** ciliated (epithelium) **;**	**2**	**DO NOT ACCEPT ‘**globlet**’** **DO NOT ACCEPT ‘**cilia cell’ ‘ciliate’
2	(a)	(ii)	(A / goblet cells) release mucus / AW **;** (mucus) traps, dust / particles / named particle **;** ciliated cell / B / cilia, wave / waft / move, mucus **;** to, top of trachea / back of mouth / AW **;**	**3 max**	**ACCEPT** release / creates / produces / secretes **DO NOT ACCEPT** excrete **ACCEPT** bacteria / microorganisms / pathogens **IGNORE** dirt / germs **DO NOT ACCEPT** ‘combines with’ **ACCEPT** ‘hair like projections’ **DO NOT ACCEPT** ‘hairs’ Idea of up and out of lungs
2	(a)	(iii)	to constrict the bronchus / AW **;**	**1**	example of AW e.g. reduce diameter of bronchus **DO NOT ACCEPT** ‘ref to increasing diameter’ – (note: if ‘increase and decrease diameter’ is used do not allow mark as it is contradiction) **ACCEPT ‘**airways’ **ACCEPT** ‘control flow of air’

Question			Expected Answers	Marks	Additional Guidance
2	(b)	(i)	short, distance / path / AW **;** (so that) diffusion / concentration, gradient is, high / steep **;** high rate of, (gas) exchange / diffusion **;**	**2 max**	**DO NOT ACCEPT** ref to number of cells / cell thickness or short space **DO NOT ACCEPT** short gradient **ACCEPT** high rate of movement of named gas in correct direction **ACCEPT '**rapid' / fast / quick **ACCEPT** ref to efficient, gas exchange / diffusion **DO NOT ACCEPT** gas exchange occurs more 'easily'
	(b)	(ii)	recoil / expel air / prevent bursting **;**	**1**	**ACCEPT** exhale more completely / force air out **DO NOT ACCEPT** 'exhale' (if used alone) **DO NOT ACCEPT** 'contract' **DO NOT ACCEPT** 'stretch' on its own **DO NOT ACCEPT** if response includes any ref to bronchus or smooth muscle
			Total	**9**	

<table>
<tr><th colspan="3">Question</th><th>Expected Answers</th><th>Marks</th><th>Additional Guidance</th></tr>
<tr><td>3</td><td>(a)</td><td></td><td>large / active, organisms have high(er), demand for oxygen / need to remove CO_2 ;
small(er), <u>surface area to volume ratio / SA:V / surface area:volume</u> ;
surface area too small / distance too large / diffusion takes too long (to supply needs) ;</td><td>2 max</td><td>ACCEPT ORA throughout
IGNORE ref to nutrients

ACCEPT diffusion too slow
look for reason why diffusion not good enough</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td>create / maintain, (steep), diffusion / concentration, gradient ;
<table><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td>epithelium</td><td>short (diffusion) distance ;</td></tr><tr><td>capillaries</td><td>delivers carbon dioxide (to be removed from blood) / carries oxygen away (from alveoli) ;
short (diffusion) distance ;</td></tr><tr><td>diaphragm / intercostal muscles</td><td>ventilation / supply of oxygen (to alveoli) / removal of carbon dioxide (from alveoli) ;</td></tr></table></td><td>3 max</td><td>could give mark in any row as an additional mark – but only once

DO NOT ACCEPT any vague reference to ‘gases’ throughout

ACCEPT short diffusion distance here even if given above

ACCEPT breathing in and out / AW</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>(c)</td><td></td><td>diaphragm (contracts / flattens and) moves downwards ;
intercostal muscles <u>contract</u> to move ribs, up / out ;
increase <u>volume</u> of thorax ;
reduce pressure inside thorax ;
to below atmospheric pressure/creates pressure gradient / AW ;</td><td>4 max</td><td>IGNORE ref to internal / external
ACCEPT increase volume of lungs / chest
ACCEPT decrease pressure in lungs / chest
must ensure the pressure gradient is in correct direction – lower in lungs</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Question			Expected Answers	Marks	Additional Guidance
3	(d)	(i)	a clear **X** placed on any part of trace where line is sloping down **;**	**1**	**ACCEPT** label line with **X** **DO NOT ALLOW X** on tip of crest / trough
3	(d)	(ii)	3 dm^3 **;**	**1**	correct units **must** be given **ACCEPT** litres
				[Total: 11]	

Question			Answer	Marks	Guidance
4	(a)		AAA TCT GGT ;	1	
4	(b)	(i)	the correct bases inserted in **all** 3 rows before box ; correctly identifying the last base in each sequence as the labelled base ; 5 **T** **T** **T** 6 **T** **T** **T** **C** 7 **T** **T** **T** **C** **C**	2	
4	(b)	(ii)	electrophoresis ; (negatively-charged DNA) moves towards , positive electrode / anode ; smallest/smaller (fragments) move, fastest / faster ; **ora** resolution on gel sufficient to register 1, nucleotide **/** base;	3 max	**ACCEPT** positive, end /terminal **IGNORE** ref to distance **ACCEPT** lightest / shortest **ACCEPT** description ' machine detects fragments to one base in length' **IGNORE** pair
4	(c)	(i)	contraction of smooth muscle ; circular (muscle) ; extra mucus production ; inflammation ;	2 max	**ACCEPT** involuntary muscle / non-striated muscle **ACCEPT** blocked by mucus / build-up of mucus **ACCEPT** swelling / oedema **IGNORE** scarring

Question			Answer	Marks	Guidance
4	(c)	(ii)	(reduced diameter means) increased **,** resistance to air flow / friction **;** *idea that* exhalation is passive / no (muscular) force behind exhalation / requires additional, force / pressure, to exhale**;**	**1 max**	**ACCEPT** 'breathes harder'
4	(d)		(mutation) change in (DNA) nucleotide/ base, sequence **;** (mutation causes) change in, amino acid sequence / primary structure (of protein) **;** change in **,** tertiary structure/ 3D shape / binding site **,** of <u>receptor</u> **;** salmeterol unable to bind **;** *idea that* no response triggered in cell / no second messenger system activated **;**	**3 max**	**IGNORE** triplet/codon/gene / frameshift **DO NOT CREDIT** active site **ACCEPT** salmetorol not complementary shape to <u>receptor</u> **ACCEPT** salmeterol cannot bind as easily e.g. adenyl cyclase not activated **IGNORE** 'has no effect'
4	(e)	(i)	(mutation resulted in) <u>receptor</u> having complementary shape to montelukast **;** montelukast able to bind **;** (whereas) salmeterol cannot **;** montelukast may have a different <u>receptor</u> **;**	**2 max**	**DO NOT CREDIT** active site **IGNORE** fit **ACCEPT** attach **ACCEPT** cannot bind as easily **ACCEPT** montelukast receptors not damaged
4	(e)	(ii)	not reliable because, sample size **too** small / **only** 62 children in study; **or** could be reliable because 31 is quite a large sample **;**	**1**	**<u>Note</u>** *31 is a suitable number for a phase 1 trial*
4	(e)	(iii)	(epithelial) cells lining cheek **;**	**1**	**ACCEPT** (named) white blood cells in saliva / salivary gland cells
			Total	**16**	

Question			Expected Answers	Marks	Additional Guidance
5	**(a)**	**(i)**	**A** = plasma / cell surface**,** membrane **;** **B** = DNA / chromosome / chromatin / genetic material **;**	2	**DO NOT CREDIT** membrane, cell membrane **DO NOT CREDIT** chromosome**s** (do not accept plural) **CREDIT** loop of / circle of, DNA **DO NOT CREDIT** plasmid, RNA **ACCEPT** nucleoid
5	**(a)**	**(ii)**	production of ATP **;** aerobic respiration **;**	max 1	**ACCEPT** named stages of aerobic respiration e.g. Krebs cycle, oxidative phosphorylation, ETC, chemiosmosis, link reaction, substrate level phosphorylation **DO NOT CREDIT** glycolysis, ATP *for* respiration **DO NOT CREDIT** *produce* energy (in form of ATP) **IGNORE** provide / release energy unqualified
5	**(a)**	**(iii)**	protein synthesis / translation **;** photosynthesis / described **;**	2	**ACCEPT** production / creation, of proteins / polypeptides, assembly of proteins from amino acids **IGNORE** autotrophic nutrition **DO NOT CREDIT** absorption of light unqualified
5	**(b)**		large surface area to volume ratio **;** small so demand for**,** O_2 / CO_2**,** is low **;** *idea of:* diffusion (alone) is adequate to meet needs **;**	2	**ACCEPT** large SA**:**Vol or large SA/Vol **ACCEPT** small Vol**:**SA ratio or small Vol/SA **DO NOT CREDIT** large surface area alone **IGNORE** gases alone, nutrients **ACCEPT** *idea of* : body SA large enough to meet needs by diffusion **ACCEPT** idea of : diffusion distance short

Question			Expected Answers	Marks	Additional Guidance
5	(c)		<table><tr><td>cell / tissue</td><td>function in the lungs</td><td></td></tr><tr><td></td><td></td><td></td></tr><tr><td></td><td>recoil **OR** return to original**,** size / shape **OR** to help expel air **OR** prevents alveoli bursting</td><td>;</td></tr><tr><td></td><td>waft / wave / move / AW**,** mucus</td><td>;</td></tr><tr><td></td><td>secrete / release / produce, mucus</td><td>;</td></tr><tr><td></td><td>constrict the airway / AW</td><td>;</td></tr></table>	4	**IGNORE** stretch / expand **ACCEPT** ref to lungs, alveoli, airways recoiling etc **DO NOT CREDIT** ref trachea / bronchi recoiling **ACCEPT** transport / remove**,** mucus **DO NOT CREDIT** dirt particles without ref to mucus **DO NOT CREDIT** excrete mucus **ACCEPT** narrows lumen OR controls, airflow / diameter, of airways **DO NOT CREDIT** ref to alveoli OR greater airflow
			Total	**11**	