

Question		Expected Answers		Mark	Additional Guidance
1	(a)		(enzymes are) proteins / used in metabolism / used in named metabolic pathway ; alter rate of (chemical) reaction / lowers activation energy / provides alternative route for reaction / is not changed / is not used up ;	2	ACCEPT 'used in reactions , in organisms / in the body' IGNORE 'biological / enzyme / in nature' ACCEPT does not take part in reaction Note 'speed up metabolic reactions' = 2 marks
1	(b)	(i)	time ;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks IGNORE 'how long' IGNORE correct units
1	(b)	(ii)	<p>P1 <i>idea of</i> different samples have different concentrations of, catalase / enzyme ;</p> <p>One of</p> <p>M1 source the extract for the whole experiment from a single source ;</p> <p>M2 <u>thorough</u> , mixing , required before use ;</p> <p>M3 filter / purify , extract ;</p> <p>M4 <i>idea of</i> using , known / standard , concentration of enzyme ;</p> <p>M5 commercial source of catalase ;</p>	2	<p>The M mark can be awarded without a correct P mark</p> <p>P1 Look for the idea of variation within the sample (e.g. different amounts) CREDIT examples of lack of uniformity such as: breakage of cells / surface area / mixing / disruption of lysosomes / changes to enzyme shape (caused by blending process) / presence of other substances interfering with reaction</p> <p>IGNORE refs to celery being a poor source of catalase</p> <p>M1 ACCEPT 'from same plant'</p>

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1	(b)	(iii)	repeat / replicate ; compare replicate values / identify anomalous results ; mean / range / standard deviation / error bars / % error ; compare results with , others / book / internet , values / results ;	2 max	e.g compare replicates with Table 2.1 IGNORE average Must contain the idea of other investigators ACCEPT 'look up normal values on the internet'
1	(c)	(i) 1 2 3 4 5 6	<u>rate</u> , rises / increases , initially ; peak at / maximum at / highest at / decrease after, <u>40</u> (°C) ; (overall) fall more rapid than rise ; <i>idea that</i> before peak / after peak , temperature increase has increasing effect on rate ; comparative figures to support any point ; no , reaction / oxygen produced , at 60(°C) ;	4 max	IGNORE explanations 1 DO NOT CREDIT if 'rate' not stated for this mp only 2 ACCEPT optimum 3 Look for a comparative statement 4 ACCEPT , e.g., line is steeper between 30 and 40 than between 10 and 20. 5 Two temperatures and two rates, with units . Or calculated difference with appropriate units, e.g. rate doubles between 10 and 20°C or $Q_{10} = 2$ 6 ACCEPT rate is 0 at 60
1	(c)	(ii)	2 ;	1	IGNORE units
1	(c)	(iii)	temperature ; maximum / peak / V_{max} ; <u>denatured</u> ; <u>active</u> ;	4	Mark the first answer for each letter. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks ACCEPT kinetic energy / KE ACCEPT optimum / optimum temperature IGNORE descriptions
Total				[16]	

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2	(a)	(i)	blue-black / black / dark blue ;	1	ACCEPT dark purple / purplish-blue DO NOT CREDIT blue or purple unqualified by darkness ACCEPT acceptable colour change
2	(a)	(ii)	<p>1 between oxygen and hydrogen (atoms) ;</p> <p>2 (between) electronegative / δ^-, and electropositive / δ^+ ;</p>	2	CREDIT marking points from clearly labelled diagram max 1 if incorrect charges are on atoms 1 DO NOT CREDIT molecules / ions 2 DO NOT CREDIT ions / + and – 2 ACCEPT slight / partial (negative / positive), charge
2	(a)	(iii)	<p>1 hydrogen / H, bonds break ;</p> <p>2 <u>helix</u>, lost / unravels / AW ;</p> <p>3 iodine, released / no longer in complex / AW ;</p>	2 max	IGNORE refs to denaturation 2 ACCEPT spiral / coil 3 ACCEPT no longer contained in helix

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2	(b)	<p>1 take samples at a range of times / AW ;</p> <p>B2 same <u>volumes</u> (of solutions) added / removed (each time) ;</p> <p>B3 heat with, Benedict's (solution) / CuSO₄ and NaOH ;</p> <p>B4 (use of) excess Benedict's ;</p> <p>B5 changes to, green / yellow / orange / brown / (brick) red ;</p> <p>C6 remove precipitate / obtain filtrate ;</p> <p>C7 colorimeter ;</p> <p>8 calibrate / zero, using, a blank / water / (unreacted) Benedict's ;</p> <p>9 use (red / orange) filter ;</p> <p>T10 reading of, transmission / absorbance OR mass of precipitate ;</p> <p>11 more transmission / less absorbance, of filtrate, OR greater mass ppt, = more maltose present ; ora</p> <p>12 using, standard / known, concentrations (of maltose) ;</p> <p>13 (obtain) <u>calibration</u> curve ;</p> <p>14 <u>plot</u>, transmission / absorbance / mass of ppt, against (reducing sugar) concentration ;</p> <p>15 <u>use graph</u> to read off concentration of maltose / AW ;</p>	6 max	<p>B2 must be in context of Benedict's test rather than reaction mixture</p> <p>B3 DO NOT CREDIT boil / warm</p> <p>B3 DO NOT CREDIT if Benedict's added to the mixture at the beginning</p> <p>C6 CREDIT description of method e.g. filtering / centrifuging / decanting</p> <p>8 IGNORE 'control'</p> <p>9 DO NOT CREDIT if colour of filter is incorrect</p> <p>T10 ACCEPT 'measure how much light, does / does not, pass through'</p> <p>11 if unfiltered Benedict's / precipitate is clearly indicated as being present in sample, ACCEPT 'less transmission / more absorbance, = more maltose present'</p> <p>11 DO NOT CREDIT if precipitate is added to colorimeter</p> <p>12 CREDIT 'serial dilutions'</p>
		QWC – correct sequence ;	1	1 of mps B2 to B5 , then mp C6 or C7 , then mp T10

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2	(c)	(i)	<p>1 increases / greater / faster ;</p> <p>2 reaction completed in / plateaus after / concentration is 100% after, 3.5 minutes ;</p> <p>3 figures with units to support mp 1 ;</p>	2 max	<p>1 ACCEPT any time between 3.45 and 3.55 min.</p> <p>3 two maltose concentrations (+ or – chloride) for a given time or two times (+ or – chloride) for given maltose concentration.</p> <p>3 ACCEPT calculated difference</p> <p>3 DO NOT CREDIT if ‘%’ and ‘min.’ not given</p> <p>3 ACCEPT any concentration within $\pm 1\%$ and time within ± 0.05 min.</p>																																																		
			<table border="1"> <thead> <tr> <th rowspan="2">Presence or absence of chloride ions</th> <th colspan="10">The percentage concentration of maltose (%) present every half a minute</th> </tr> <tr> <th>0.0 min</th> <th>0.5 min</th> <th>1.0 min</th> <th>1.5 min</th> <th>2.0 min</th> <th>2.5 min</th> <th>3.0 min</th> <th>3.5 min</th> <th>4.0 min</th> </tr> </thead> <tbody> <tr> <td>Chloride ions present</td> <td>0</td> <td>24</td> <td>54</td> <td>70</td> <td>80</td> <td>88</td> <td>95</td> <td>100</td> <td>100</td> </tr> <tr> <td>Chloride ions absent</td> <td>0</td> <td>12</td> <td>20</td> <td>29</td> <td>36</td> <td>40</td> <td>45</td> <td>48</td> <td>50</td> </tr> <tr> <td>Difference in maltose concentration When chloride ions are either present or absent</td> <td>0</td> <td>12</td> <td>34</td> <td>41</td> <td>44</td> <td>48</td> <td>50</td> <td>52</td> <td>50</td> </tr> </tbody> </table> <p>Allow a + /- 1% for any concentration of maltose and a +/- 2% for the difference in maltose concentrations</p>	Presence or absence of chloride ions	The percentage concentration of maltose (%) present every half a minute										0.0 min	0.5 min	1.0 min	1.5 min	2.0 min	2.5 min	3.0 min	3.5 min	4.0 min	Chloride ions present	0	24	54	70	80	88	95	100	100	Chloride ions absent	0	12	20	29	36	40	45	48	50	Difference in maltose concentration When chloride ions are either present or absent	0	12	34	41	44	48	50	52	50		
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2	(c)	(ii)	<p>1 (acts as a) cofactor ;</p> <p>2 (Cl⁻) binds to, enzyme / amylase / amylose / substrate ;</p> <p>3 enzyme substrate complex / ESC, forms more, easily / quickly ;</p>	2 max	<p>1 IGNORE ‘coenzyme’</p> <p>2 ACCEPT binds to, active site</p> <p>3 ACCEPT description</p>																																																		

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2	(c)	(iii)	<p>1 temperature ;</p> <p>2 pH ;</p> <p>3 enzyme / amylase / chloride, <u>concentration</u> ;</p> <p>4 substrate / starch / amylose, <u>concentration</u> ;</p> <p>5 constant / regular, stirring ;</p> <p>6 (fixed) <u>volume</u> of solution (removed each time for sampling) ;</p>	3 max	<p>Mark the first three answers only regardless of which line they are on DO NOT CREDIT refs to, time</p> <p>3 IGNORE 'amount' or 'volume' 3 DO NOT CREDIT 'concentration' unqualified</p> <p>4 IGNORE 'amount' or 'volume' 4 DO NOT CREDIT 'concentration' unqualified</p>
			Total	19	

Question			Expected Answers	Marks	Additional Guidance
3	(a)	(i)	X ;	1	
3	(a)	(ii)	<p>1 substrate / PABA, and, inhibitor / sulfonamide, similar shape ;</p> <p>2 able to, bind / fit into / block, <u>active site</u> ;</p> <p>3 (shape) <u>complimentary</u> to <u>active site</u> ;</p> <p>4 both have, hex / benzene / 6-C, (ring) ;</p> <p>5 both have, NH₂ / amine ;</p> <p>6 correct ref to a difference between sulfonamide and PABA ;</p>	3 max	<p>1 ACCEPT similar structure DO NOT CREDIT same shape</p> <p>3 DO NOT CREDIT refs to PABA and sulfonamide being complementary to each other or to the enzyme (alone)</p> <p>6 e.g. only sulfonamide contains S sulfonamide has 1 more NH₂ group sulfonamide has SONH₂ but PABA has N₂ only PABA has COOH group</p>
3	(b)	(i)	<p><i>without inhibitor</i></p> <p>1 more, PABA / substrate, molecules enter <u>active site</u> ;</p> <p>2 more, enzyme substrate complexes / ESCs, formed ;</p> <p>3 at low concentration not all active sites occupied / at high concentration all active sites occupied ;</p> <p>4 achieves / reaches, max (turnover) rate / V_{max} ;</p> <p>5 (at high substrate concentration) enzyme concentration limiting ;</p>	3 max	<p>1 ACCEPT more successful collisions between substrate and active site</p> <p>3 ACCEPT active sites filled / no free active sites DO NOT CREDIT active sites run out</p> <p>4 ACCEPT 'cannot work any quicker' DO NOT CREDIT 'optimum rate' or 'rate levels off'</p>

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3	(b)	(ii)	<i>with inhibitor</i> 1 inhibitor / sulfonamide, can, fit / block / bind to / compete for, <u>active site</u> ; 2 (occupies it) for a short time / temporary / reversibly ; 3 fewer active sites available (for substrate) / AW ; 4 (idea of) more substrate reduces chance of inhibitor getting in;	2 max	3 ACCEPT substrate can't access active site 4 ACCEPT more ESC formed in context of overcoming inhibition / substrate can out-compete inhibitor
3	(c)		1 mutation ; 2 sulfonamide is <u>selective</u> , agent / pressure ; 3 resistant survive / non resistant die ; 4 (resistance) allele / gene / mutation, passed to, offspring / next generation ; 5 (happens) over many generations ; 6 AVP ;	4 max	DO NOT CREDIT immune for any mark point 3 IGNORE refs to (survivors) breed / reproduce ; 5 IGNORE refs to time. Look for generations 6 e.g. mutation is, random / spontaneous allele / gene, passed on by, plasmids / horizontal transmission
3	(d)	(i)	<u>bacteria</u> , killed / destroyed / cannot grow / lyse, in presence of antibiotic ;	1	DO NOT CREDIT 'antibiotic works better' or 'there are no bacteria there' or 'bacteria are broken down'
3	(d)	(ii)	streptomycin ;	1	IGNORE '4' as it is the number rather than the name

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3	(d)	(iii)	<p>1 cheap / AW ;</p> <p>2 (test is) quick to carry out / (deals with several antibiotics) at same time / AW ;</p> <p>3 (idea of) allowing early treatment of patient ;</p> <p>4 (idea of) compares antibiotics under same conditions ;</p> <p>5 (correct antibiotic first time) to prevent antibiotic resistance developing ;</p>	3 max	<p>DO NOT CREDIT responses which simply refer to selecting the best antibiotic</p> <p>2 DO NOT CREDIT speed of antibiotic action</p>
3	(e)		<p>(new) drugs come from (named) organisms ;</p> <p>biodiversity is reducing ;</p> <p>habitats / named habitat, destroyed / lost ;</p> <p><u>reason</u> for habitat destruction ;</p>	2 max	<p>ACCEPT plants / animals / fungi / species / etc.</p> <p>ACCEPT deforestation / natural environment <u>lost</u></p> <p>e.g. global warming logging fuel crops construction / industrialisation mining fishing pollution tourism</p> <p>ACCEPT any other valid reason that will destroy natural habitats but not general statements such as 'human development' or 'business'</p>
			Total	20	