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)	**P1**	*idea of* different samples have different concentrations of, catalase / enzyme **;**	**2**	The M mark can be awarded without a correct P mark **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 **IGNORE** refs to celery being a poor source of catalase
			One of			
			M1	source the extract for the whole experiment from a single source **;**		**M1 ACCEPT** 'from same plant'
			M2	thorough , mixing , required before use **;**		
			M3	filter / purify , extract **;**		
			M4	*idea of* using , known / standard , concentration of enzyme **;**		
			M5	commercial source of catalase **;**		

Question			Expected Answers	Mark	Additional Guidance
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	 rate , rises / increases , initially ; peak at / maximum at / highest at / decrease after, 40(°C) ; (overall) fall more rapid than rise ; *idea that* 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} ; denatured ; active ;	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]**	

Question			Expected Answer	Mark	Additional Guidance
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)		2	**CREDIT** marking points from clearly labelled diagram max 1 if incorrect charges are on atoms
		1	between oxygen and hydrogen (atoms) **;**		**1 DO NOT CREDIT** molecules / ions
		2	(between) electronegative / δ^-, and electropositive / δ^+ **;**		**2 DO NOT CREDIT** ions / + and – **2 ACCEPT** slight / partial (negative / positive), charge
2	(a)	(iii)		2 max	**IGNORE** refs to denaturation
		1	hydrogen / H, bonds break **;**		
		2	helix, lost / unravels / AW **;**		**2 ACCEPT** spiral / coil
		3	iodine, released / no longer in complex / AW **;**		**3 ACCEPT** no longer contained in helix

Question			Expected Answer	Mark	Additional Guidance
2	(b)	1	take samples at a range of times / AW **;**		
		B2	same volumes (of solutions) added / removed (each time) **;**		**B2** must be in context of Benedict's test rather than reaction mixture
		B3	heat with, Benedict's (solution) / $CuSO_4$ and NaOH **;**		**B3 DO NOT CREDIT** boil **/** warm **B3 DO NOT CREDIT** if Benedict's added to the mixture at the beginning
		B4	(use of) excess Benedict's **;**		
		B5	changes to, green / yellow / orange / brown / (brick) red **;**		
		C6	remove precipitate / obtain filtrate **;**		**C6 CREDIT** description of method e.g. filtering / centrifuging / decanting
		C7	colorimeter **;**		
		8	calibrate / zero, using, a blank / water / (unreacted) Benedict's **;**		**8 IGNORE** 'control'
		9	use (red / orange) filter **;**		**9 DO NOT CREDIT** if colour of filter is incorrect
		T10	reading of, transmission / absorbance **OR** mass of precipitate **;**		**T10 ACCEPT** 'measure how much light, does / does not, pass through'
		11	more transmission / less absorbance, of filtrate, **OR** greater mass ppt, = more maltose present **; ora**		**11** if unfiltered Benedict's / precipitate is **clearly indicated** as being present **in sample**, **ACCEPT** 'less transmission / more absorbance, = more maltose present' **11 DO NOT CREDIT** if precipitate is added to colorimeter
		12	using, standard / known, concentrations (of maltose) **;**		**12 CREDIT** 'serial dilutions'
		13	(obtain) calibration curve **;**		
		14	plot, transmission / absorbance / mass of ppt, against (reducing sugar) concentration **;**		
		15	use graph to read off concentration of maltose / AW **;**	**6 max**	
			QWC – correct sequence **;**	**1**	1 of mps **B2 to B5**, *then* mp **C6 or C7**, *then* mp **T10**

<table>
<tr><th colspan="3">Question</th><th>Expected Answer</th><th>Mark</th><th>Additional Guidance</th></tr>
<tr><td>2</td><td>(c)</td><td>(i)</td><td>
1 increases / greater / faster ;
2 reaction completed in / plateaus after / concentration is 100% after, 3.5 minutes ;
3 figures with units to support mp 1 ;
</td><td>2 max</td><td>
1 ACCEPT any time between 3.45 and 3.55 min.

3 two maltose concentrations (+ or – chloride) for a given time or two times (+ or – chloride) for given maltose concentration.
3 ACCEPT calculated difference
3 DO NOT CREDIT if ‘%’ and ‘min.’ not given
3 ACCEPT any concentration within ± 1 % and time within ± 0.05 min.
</td></tr>
<tr><td></td><td></td><td></td><td colspan="4">
<table>
<tr><th rowspan="2">Presence or absence of chloride ions</th><th colspan="9">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>
<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>
</table>
Allow a + /- 1% for any concentration of maltose and a +/- 2% for the difference in maltose concentrations
</td></tr>
<tr><td>2</td><td>(c)</td><td>(ii)</td><td>
1 (acts as a) cofactor ;
2 (Cl^-) binds to, enzyme / amylase / amylose / substrate ;
3 enzyme substrate complex / ESC, forms more, easily / quickly ;
</td><td>2 max</td><td>
1 IGNORE ‘coenzyme’

2 ACCEPT binds to, active site

3 ACCEPT description
</td></tr>
</table>

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

Question			Expected Answers	Marks	Additional Guidance
3	**(a)**	**(i)**	X ;	**1**	
3	**(a)**	**(ii)**	**1** substrate / PABA, **and**, inhibitor / sulfonamide, similar shape**;** **2** able to, bind / fit into / block, active site **;** **3** (shape) complimentary to active site **;** **4** both have, hex / benzene / 6-C, (ring) **;** **5** both have, NH_2 / amine **;** **6** correct ref to a difference between sulfonamide and PABA **;**	**3 max**	**1 ACCEPT** similar structure **DO NOT CREDIT** same shape **3 DO NOT CREDIT** refs to PABA and sulfonamide being complementary to each other or to the enzyme (alone) **6** e.g. only sulfonamide contains S sulfonamide has 1 more NH_2 group sulfonamide has $SONH_2$ but PABA has N_2 only PABA has COOH group
3	**(b)**	**(i)**	*without inhibitor* **1** more, PABA / substrate, molecules enter active site **;** **2** more, enzyme substrate complexes / ESCs, formed **;** **3** at low concentration not all active sites occupied / at high concentration all active sites occupied **;** **4** achieves / reaches, max (turnover) rate / V_{max} **;** **5** (at high substrate concentration) enzyme concentration limiting **;**	**3 max**	**1 ACCEPT** more successful collisions between substrate and active site **3 ACCEPT** active sites filled / no free active sites **DO NOT CREDIT** active sites run out **4 ACCEPT** 'cannot work any quicker' **DO NOT CREDIT** 'optimum rate' or 'rate levels off'

Question			Expected Answers	Marks	Additional Guidance
3	**(b)**	**(ii)**	*with inhibitor* **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

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