

Enzymes

Mark Scheme 3

Level	IGCSE
Subject	Biology
Exam Board	CIE
Topic	Enzymes
Paper Type	(Extended) Theory Paper
Booklet	Mark Scheme 3

Time Allowed: 68 minutes

Score: /56

Percentage: /100

Question	E	Answers	Marks	Additional Guidance
1 (a)		broad leaves / <i>Ranunculus</i> does not have narrow leaves / AW ; branched veins / not parallel veins ; flower parts, in 5s / not in 3s ; R 'flowers in fives'	[max 2]	A wide / large surface area A net(work) of veins / reticulate I two cotyledons
(b)	1 2 3 4 5 6 7 8 9	(cells of W were) in, the winter / cold / low light / short days / AW ; I refs. to water starch, has been used / converted to glucose or sugar / broken down ; to provide energy ; R 'produce' in respiration ; to keep the, plant / cells, alive ; I for growth, etc. root has become a source (not a sink) ; when there has been, no / few, leaves ; so there has been, no / little / less, photosynthesis ; ref. to, light / temperature / cold, as limiting factor(s) ;	[max 3]	<i>assume answers refer to W unless told otherwise – accept ORA for S</i> 1 (cells of S were) in summer / warm / high light / AW ; I refs. to water 2 starch has been, stored / produced ; 8 result of (more) photosynthesis ; 6 root is a sink (not a source) ; 7 many leaves ;
(c)	1 2 3 4 5 6 7 8 9	sucrose / sugar, transported / translocated ; A travels / in phloem glucose / monosaccharide ; joined together (by chemical bonds) ; R if refers to joining sucrose condensation reaction / described ; glucose added to growing chain / AW ; (starch is a) long / chain, molecule ; A is a polysaccharide enzyme provides active site for reaction ; enzyme, catalyses / speeds up, the reaction ; ref. to lock and key (model) ;	[max 3]	<i>if given breakdown of starch award MP6 to 9 only</i> A 'join together to make maltose' A polymer / polymerisation A enzyme(s) is/are (biological) catalyst(s)

Question	E	Answers	Marks	Additional Guidance
1 (d)	1 2 3 4 5	increase in (kinetic) energy ; more, collisions / AW ; between, enzyme / active site, and, substrate / AW ; ref. to optimum temperature / works best at $\approx 30^{\circ}\text{C}$; <u>denatured</u> , at high temperature / above 30°C / above optimum ;	[max 2]	I particles, movement R 'destroyed' / 'killed' / 'damaged'
[Total: 10]				

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Question	E	Answers	Marks	Additional Guidance
2 (a)	1 2 3 4 5 6 7	substrate / sucrose, fits into enzyme ; <u>active site</u> ; ref to shape of molecules, fitting together / matching / AW ; <u>lock and key</u> ; sucrose and water / molecules, close together within enzyme ; glucose and fructose produced + enzyme, unchanged / reused ; lowers energy needed for reaction ;	[max 3]	R similar/same shape A form, enzyme substrate complex / ESC
(b) (i)		temperature constant so not another variable / AW ; (near) optimum temperature ; denatures at higher temperatures / less or not active at lower temperature ;	[max 2]	R denatures at lower temperatures
(ii)	1 2 3 4	increase in activity from pH 3 to pH 7 / ORA; optimum pH / peak activity, pH 7 ; decrease in activity from pH 7 to pH 11 / ORA; any rate of activity quoted ;	[max 3]	A pH 6.8 – 7.2 A neutral pH R 6 – 7 A correct ref. to no activity below pH 3 or above pH 11
(iii)		P – pepsin / protease ; Q – amylase / carbohydrase ; R – lipase / trypsin / protease / amylase / carbohydrase / maltase / sucrase / lactase ;	[3]	
(c)	1 2 3 4 5 6	<i>marking points not linked – allow ecf</i> amylase, breaks down starch ; starch → maltose / glucose / sugar(s) ; (named) protease, breaks down protein ; protein → polypeptides / peptides / amino acids ; lipase, breaks down fats ; fat → fatty acids <u>and</u> glycerol ;	[max 4]	alternatives for MP1: (named) carbohydrase breaks down (correctly named) carbohydrate alternatives for MP2: maltose → glucose / sucrose → glucose <u>and</u> fructose / carbohydrates → sugars
[Total: 15]				

- 3 (a) *description required not an explanation, so ignore collisions / denaturation*
MP3 may be awarded for comments within the range 50 °C to 90 °C
- 1 no activity, at / below, 10 °C ;
 - 2 increased activity between 10 °C and 90 °C ;
 - 3 steep(est) increase / exponential increase, between 50 or 60 °C and 90 °C ;
 - 4 optimum / peak / maximum, at 90 °C ; **A** 'works best at' / most active at
 - 5 above 90 °C activity decreases ; [3 max]
- (b) *ignore details of genetically modified bacteria*
- 1 (bacteria grown in) fermenter / bioreactor / vat ; **R** tanks
 - 2 (bacteria provided with) substrate / feedstock / food substances / glucose /
sugars / starch / minerals / whey / waste substances / nutrients / amino
acids / AW ;
R food / raw materials
 - 3 oxygen / aerobic conditions ; **A** air bubbled through / aerated
 - 4 optimum conditions / 26 °C / pH 5–6 / sterile ;
 - 5 stirred to, prevent settling / mix bacteria with nutrients ;
 - 6 (bacteria) grow / reproduce / divide / multiply, rapidly ;
 - 7 (extracellular) enzymes, secreted / released / AW ; **R** production
 - 8 enzymes, extracted / harvested / separated / collected / removed (from,
bacteria / mixture) ;
A ref to filtration / crushing bacteria **R** crushing enzymes [4 max]

(c) *enzymes must be in the correct context*
do not award MP9 if there are no other points made

- 1 protein digested to, amino acids / (poly)peptides ; **A** broken down / hydrolysed
- 2 (by) protease(s) ;
- 3 fats digested to fatty acids (and glycerol) ;
- 4 (by) lipase(s) ; **R** lipase
- 5 (by) amylase ;
- 6 starch to, sugar, maltose, glucose ;
- 7 (by) cellulase ;
- 8 breakdown cellulose (fibres) to release stains ; **A** reduces pilling
- 9 *idea that products are, soluble / washed away (in the water) ;*

[4 max]

- (d)
- 1 thrombin / protease ;
 - 2 fibrinogen converted to fibrin ;
 - 3 soluble (protein) converted to insoluble (protein) ;
 - 4 fibrin, traps blood cells / forms mesh / forms 'nets' ;

[3 max]

[Total: 14]

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- 4 (a) (i) excretion ; [1]
- (ii) biological ; **A** made by, cells / organisms
catalyst / described ;
(made of) protein / AW ;
bio-catalyst = 2 marks [max 2]
- (b) (i) pH ; **A** ph / PH / Ph [1]
- (ii) temperature ; **R** heat *ignore* room
size / mass / quantity / amount / surface area / type, of potato ;
volume of hydrogen peroxide ;
concentration of hydrogen peroxide ;
A 'amount' with respect to hydrogen peroxide
R refs to catalase / enzyme [max 2]
- (c) *award two marks if correct answer (0.56 / 0.57 / 0.58) is given – may be in white space below the table*
if no answer or incorrect answer award one mark for correct working
if 0.5 or 0.6 award one mark
10 divided by 17.4
0.56 / 0.57 / 0.58 ;; [2]

(d) graph [2]

- 1 x-axis labelled pH ;
- 2 y-axis labelled – must have units
rate (of oxygen production / of reaction), $\text{cm}^3 \text{ min}^{-1}$ / $\text{cm}^3 \text{ per min}$;
- 3 points all correct ; use the overlay, but **A** *ecf* from (c)
- 4 continuous and clear line , which may be either a curve which may not go through all the points or straight lines between points
R if line goes beyond plotted points [4]

(e) (i) increase in rate to (pH) 6 then decrease / reaches a peak at (pH) 6 ;
any rate given as a data quote, **with $\text{cm}^3 \text{ min}^{-1}$ / $\text{cm}^3 \text{ per min}$** ; [2]

(ii) pH 6 is, optimum / when enzyme 'works best' ;

following points may refer to optimum or sub-optimum

ref to shape of enzyme ;

ref to active site ;

ref to denaturation ; **A** destroyed **R** 'killed'

ref to substrate / hydrogen peroxide, fitting into, enzyme / active site ;

[max 3]

[Total: 17]