UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

Pre-U Certificate

MARK SCHEME for the May/June 2012 question paper

for the guidance of teachers

9790 BIOLOGY

9790/04 Paper 4 (Practical), maximum raw mark 70

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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UNIVERSITY of CAMBRIDGE
International Examinations

Skill	Approximate total marks	Breakdown of the marks	Q.1	Q.2	Q.3	Q.4	Q. 5	Total
Manipulation, measurement and observation	24	Successful collection of data and observations (MMO collection)	3	11				22
		Decisions about measurements or observations (MMO decisions)	6	2				
Presentation of data and observations	13	Recording data and observations (PDO recording)	2					15
		Display of calculation and reasoning (PDO display)	2	4				
		Data layout (PDO layout)	1	3			3	
Planning	16	Defining the problem (P)			6			16
		Methods (M)			10			
Analysis, conclusions and evaluation	17	Interpretation of data or observations and identifying sources of error (D)				8	2	17
		Suggesting improvements and evaluation (E)				2		
		Conclusion (C)					5	
Total	**70**		**14**	**20**	**16**	**10**	**10**	**70**

Section A

Question	Sections	Learning outcomes	Indicative material		Mark
			there are 16 marking points available – mark to max 14		
1	MMO decisions	• decide how many tests, measurements or observations to perform • make measurements or observations that span the largest possible range within the limits either of the equipment provided or of the instructions given	**1** **2** **3** **4** **5** **6**	evidence that each solution tested for reducing sugars **;** evidence that each solution tested for non-reducing sugars **;** an explanation that reducing sugar test is followed by the non-reducing sugar test on all samples **;** *results as* final colour/colour change/time for first appearance of green/precipitate **;** different colours for any one sample following acid hydrolysis and neutralisation **;** repeats **;**	[6]
	MMO collection	• set up apparatus correctly • work out what to do from outline instructions given in the form of written instructions or diagrams • use their apparatus to collect an appropriate quantity of data or observations, including subtle differences in colour or other properties of materials	**7** **8** **9**	correct results recorded for solutions **C1** to **C5 ;** colours/precipitate, recorded unambiguously **;** no, change in colour/precipitate, with **C1** in at least one test **;**	[3]

Question	Sections	Learning outcomes	Indicative material		Mark
1	PDO recording PDO layout	• present numerical data, values or observations in a single table of results • draw up the table before taking readings/making observations, so that candidates can record directly into the table, to avoid the need to copy up their results • include in the table of results, if necessary, columns for raw data, for calculated values and for deductions • use column headings that include the quantity and the unit (as appropriate) and that conform to accepted scientific conventions • choose a suitable and clear method of presenting the data, e.g. tabulations, chart, graph, drawing or mixture of methods of presentation	**10** **11** **12** **13** **14**	data for, colours/precipitate/times, and any other observations recorded as a single table **;** no evidence of copying up their results **;** informative column headings **;** *e.g.* test solution/sample, final colour, precipitate, sugar content, degree of stickiness results linked correctly to relative reducing sugar content **;** **A** ecf more intense colour in **C3** with non-reducing sugar test compared with reducing sugar test **;**	[5]
	PDO display	• show their working in calculations, and the key steps in their reasoning	*allow ecf from results* **15** **16**	deductions about sugar content of fibres **;** any deductions about 'stickiness' **;**	[2]
					[Total: 14]

Question	Sections	Learning outcomes	Indicative material		Mark
2 (a)	MMO collection	• set up apparatus correctly • use their apparatus to collect an appropriate quantity of data or observations, including subtle differences in colour or other properties of materials	**1** **2** **3** **4** *labels* **5** **6** **7**	correct outline of **five** seminiferous tubules of appropriate relative sizes with complete lines **;** layers within the tubule and outline of lumen shown **;** *e.g.* connective tissue, germinal epithelium, cells undergoing meiosis, spermatozoa interstitial tissue/cells of Leydig/connective tissue **;** capillaries/blood vessels **;** seminiferous tubule(s) **;** interstitial tissue/cells of Leydig/blood vessel/capillary **;** two regions within tubule **;** *e.g.* connective tissue/germinal epithelium, lumen/sperm	[6 max]
(b)	MMO collection PDO display PDO layout	• make measurements using millimetre scales, graticules, protractors, stopwatches, balances, measuring cylinders, syringes, thermometers, and other common laboratory apparatus • show their working in calculations, and the key steps in their reasoning • choose a suitable and clear method of presenting the data, e.g. tabulations, chart, graph, drawing or mixture of methods of presentation	**1** **2** **3** **4** **5** **6** **7**	measurements of seminiferous tubules given in, graticule units/μm, within acceptable range **;** calibration shown (within appropriate range) **;** diameters converted to, micrometres/millimetres, correctly **;** **A** standard form mean calculated **;** standard deviation calculated **;** *answers must be given to appropriate significant figure – penalise once only* *e.g.* 340 μm ± 75.2 tubules **A** to **E** and diameters recorded **;** appropriate units used throughout **;** *not necessarily in a table*	[1] [4] [2]

(c)	MMO collection	• use their apparatus to collect an appropriate quantity of data or observations, including subtle differences in colour or other properties of materials	**1** **2** **3** **4** **5** **6** **7**	one Sertoli cell drawn, correct relative width and length **;** large nucleus **;** nucleolus **;** spermatozoa attached to distal surface **;** correct shape of head of sperm **;** germinal epithelium **;** cells in stages of division shown on lateral surfaces of Sertoli cell **;**	[max 4]
	MMO decisions	• decide how many tests, measurements or observations to perform • make measurements or observations that span the largest possible range within the limits either of the equipment provided or of the instructions given		*labels* **8** sperm(atozoa) **;** **9** named part of sperm **;** **10** Sertoli cell + nucleus/nucleolus/cytoplasm **;** **11** germinal epithelium **;** **12** spermatogonia/spermatocytes/spermatids **;**	[max 2]
	PDO layout	• choose a suitable and clear method of presenting the data, e.g. tabulations, chart, graph, drawing or mixture of methods of presentation	**13**	cells drawn with clear, complete lines **;**	[1]
					[Total: 20]

Section B

Planning

P = defining the problem
M = methods

Analysis, conclusions and evaluation

D = interpretation of data or observations and identifying sources of error
C = drawing conclusions
E = suggesting improvements and evaluation

Question 3

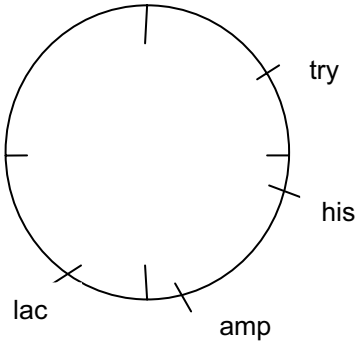
Sections	Learning outcomes	Expected answer		Mark
P defining the problem	• identify the dependent and independent variables in the experiment or investigation • express the aim in terms of a prediction or hypothesis, and express this in words and in the form of a predicted graph • identify the variables that are to be controlled	**1**	Hypothesis or prediction **;** *e.g.* rate of hydrolysis is faster using free enzyme/quantity of urea hydrolysed over time is greater with free enzyme/immobilised urease catalyses reaction over much longer period of time **A** *ora*/null hypothesis	
		2	Theory to support candidate's hypothesis or prediction **;** *e.g.* refs to accessible active sites/diffusion of substrate into alginate beads/stability of enzyme in alginate beads	
		3	Outline of strategy **;** *e.g.* method of following the reaction taking samples at intervals and calculating the initial rate	
		4	Justification/evaluation, of strategy **;** *e.g.* can only alter concentration of immobilised enzyme by changing number of beads/limitations of colour comparison *these could be awarded at the end of the plan*	
		5	Method of determining, pH / (the concentration) of ammonium carbonate, at intervals **;** *e.g.* use of pH indicator, to follow colour change	
		6	At least two control variables **;** *e.g.* temperature, concentration of urea solution, volumes used, number of beads	
		7	Risk assessment **;** ref to hazard <u>and</u> precaution *some points may be taken from a diagram or a flow or sequence diagram*	[max 6]

P methods	• describe the method to be used to vary the independent variable, and the means that they will propose to ensure that they have measured its values accurately • describe how the dependent variable is to be measured • describe how each of the other key variables is to be controlled • explain how any control experiments will be used to verify that it is the independent variable that is affecting the dependent variable and not some other factor • describe the arrangement of apparatus and the steps in the procedure to be followed • suggest appropriate volumes and concentrations of reagents, and explain how different concentrations would be prepared • assess the risks of their proposed methods • describe precautions that should be taken to keep risks to a minimum • draw up tables for data that they might wish to record • describe how the data might be used in order to reach a conclusion	**8** **9** **10** **11** **12** **13** **14** **15** **16** **17** **18** **19** **20** **21** **22** **23** **24** **25** **26**	use range of concentrations of urea **;** use range of concentrations of urease **;** *to find suitable concentrations to make comparison* dilution table(s) included **;** **A** ratios method to ensure concentration of urease in reaction mixtures is the same for both free and immobilised enzyme **;** urea solution mixed with pH indicator **;** equilibration in water bath **;** mixing, urease/beads, and urea solution at time = 0 **;** staggered start **;** samples taken at stated intervals **;** uncertainty/precision, of results **;** plot results and take gradient to give initial rate **;** colour standard set up at known pH **;** time taken (t) to reach colour standard recorded **;** rate = 1/t **;** **A** 1000/t, etc. colour change followed in colorimeter **;** repeats/replicates (calculate means) **;** calculate, standard deviation/standard error **;** ref to use of *t*-test to see if rates are significantly different **;** plot results on appropriate graph (bar or line) **;**	[max 10]
				[Total:16]

Question	Sections	Learning outcome	Expected answer		Mark
4 (a)	ACE interpretation	• describe the patterns and trends shown by tables and graphs • describe and summarise the key points of a set of observations	**1** **2** **3** **4** **5** **6**	*general statement, e.g.* more males involved, more successful breeding ; mean mass of nestlings at day 6 increases the more adults there are to feed them ; mean mass increases if males are full-time, not part-time ; similar relationships with deaths of nestlings ; comparative data quote ; ref to any result thought anomalous ;	[max 3]
(b)	ACE interpretation	• use appropriate statistical tests to assess the variability of data or the statistical differences between samples	1 v 3 = 57, not significant/ns ; 4 v 5 = 62, p <0.01 ;		[2]
(c)	ACE evaluation	• use these evaluations and provided information to make informed judgements on the confidence with which conclusions may be drawn	used to show significance or not between similar data sets ; compares mean values ; *t*-test takes into account the differences in number of nests for each breeding strategy ; *t*-test may be used with small samples ;		[max 2]
(d)	ACE interpretation	• identify the most significant sources of error in an experiment	**1** **2** **3** **4** **5** **6** **7** **8** **9**	variation in number of nests studied/AW ; *e.g.* 7 v 45 ; 7 is too small for reliable use of *t*-test ; nestling mass at day 6 may not reflect mass when they, leave the nest/first fly ; may not be significant factor in deciding how many survive ; mass/number, are not the only indicators of breeding success ; another parameter ; *e.g.* number that survive to breed *idea of* more than one feeding strategy within each reproductive strategy ; AVP; ref to SD/only one location	[max 3]
					[Total:10]

Question	Sections	Learning outcome	Expected answer	Mark
5 (a)(i)	ACE conclusion	• make detailed scientific explanations of the data and of their conclusions, drawing on the skill, knowledge and understanding that they have gained from their studies of the Pre-U syllabus	cannot make, essential compound(s)/amino acid(s) /histidine **;** no enzyme(s) present (for making histidine) **;** mutation in gene(s) **;**	[max 2]
(ii)	ACE conclusion	• make detailed scientific explanations of the data and of their conclusions, drawing on the skill, knowledge and understanding that they have gained from their studies of the Pre-U syllabus	resistant to ampicillin/AW **;** detail of mechanism of resistance **;** otherwise wild type/AW **;** has enzymes for synthesis of tryptophan, histidine and, lactase/ β galactosidase **;**	[max 2]
(b)(i)	PDO layout	• select which variable(s) to plot and plot appropriately on clearly labelled *x*- and *y*-axes • plot all points or bars to an appropriate accuracy • follow the IOB recommendations for putting lines on graphs	*x*-axis = time, *y*-axis = number of colonies, sensible scales and axes labelled appropriately with unit for time **;** points plotted correctly **;** curves/straight lines **;**	[3]
(ii)	ACE interpretation	• find an unknown value by using co-ordinates or axis intercepts on a graph	values for first entry into recipient cells read from *x*-axis correctly (± one small square) **;** genes identified correctly **;** *any four cells correct = 1 mark*	[2]

medium	gene	time of gene transfer to recipient cells / min
2	amp / AW	27
3	trp / AW	8
4	his / AW	17
5	lactase / AW	36

(c)	ACE conclusions	• draw conclusions from an investigation or from interpretations of observations, data and calculated values, providing a detailed description of the key features of the observations, data and analyses, and considering whether experimental data support a given hypothesis	genes mapped in correct order on the chromosome **;** *apply, mirror image/ecf*  	[1]
				[Total:10]