Cambridge International Examinations
Cambridge Pre-U Certificate

BIOLOGY **9790/04**

Paper 4 Practical **May/June 2016**

MARK SCHEME

Maximum Mark: 80

Published

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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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This syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 3 Pre-U Certificate.

Notes:

The following abbreviations may be used in mark schemes:

;	separates marking points
/	alternative and acceptable answers for the same marking point
allow / accept / **A**	answers that can be accepted
ignore / **I**	statements that are irrelevant – applies to neutral answers
AW / owtte	credit alternative wording / or words to that effect
ecf	error carried forward
(words)	bracketed words that are not essential to gain credit
<u>words</u>	underlined words must be present to gain credit
max	indicates the maximum number of marks that can be given
ORA	or reverse argument
AVP	any valid point – marking points not listed on the mark scheme but which are worthy of credit

Section A

Question	Indicative Material	Mark
1 (a)	1 betalain molecules are too large **;** 2 betalain molecules are, polar / charged / hydrophilic **;** 3 interact with water by formation of hydrogen bonds **;** 4 (so) will not, pass / diffuse, through hydrophobic core of bilayer / AW **;** **A** ref. to hydrophobic 'tails' of phospholipids 5 no, membrane proteins / carriers / channels / pumps / AW **;** **A** no, facilitated diffusion / active transport 6 ref. to specificity of (named) membrane protein(s) **;**	**[max 3]**
(b)	concentration is either an exact match or given as a range **;**	**[1]**
(c)	1 at least five different concentrations of alcohol, not including 0% in this total **;** 2 suitable alcohol concentrations within the range 0% to 100% **;** 3 dilutions prepared using proportional dilutions (as in Table 1.1) **;** 4 use of serial dilutions to give some or all of the concentrations **;** 5 make 10 cm^3 minimum of each solution **;** 6 AVP **;** further detail e.g. use different syringes for water and alcohol make volumes greater than 10 cm^3 (to allow for replicates / to reduce percentage error in measuring accuracy) ref. to air bubbles tubes inverted (to mix) / use of bung for mixing use small syringe for small volumes	**[max 4]**

Question	Indicative Material	Mark
(d)	1 comment on surface area of discs ; 2 step(s) taken to ensure constant thickness of discs ; **ignore** simple use of ruler and scalpel 3 any further comment on preparing discs ; e.g. discard poorly cut discs 4 discs washed, until no trace of pigment / same number of times (minimum of four) ; 5 further comment about ensuring no further leakage of pigment ; e.g. explanation involving cell damage 6 discs handled carefully so not, punctured / damaged ; 7 discs blotted before adding to alcohol ; 8 use of stopwatch / timer described ; e.g. left to run throughout investigation / staggered start 9 further description of, use of timer / method of timing ; 10 volume of alcohol solution is stated as $\geqslant 10\,cm^3$; 11 all discs submerged ; 12 standardised, shaking / stirring / mixing during the procedure ; 13 measuring the temperature / control temperature with water-bath ; 14 use of white background for colour matching ; 15 ref. to use of replicates (even if not done) ; 16 preparation of further concentrations of betalains to assess results ; 17 AVP ; any extra step e.g. invert tubes before colour check 18 AVP ; any other explanation	**[max 8]**

Question	Indicative Material	Mark
(e)	1 data recorded as a single table **;** 2 concentration of alcohol in left-hand column **;** 3 informative column headings, correct ref. to percentage in column headings **;** e.g. concentration of alcohol / %, concentration of betalains / % percentage concentration of alcohol, percentage concentration of betalains 4 results for betalain concentrations recorded to same appropriate degree of precision in each column **;** **A** whole number or 1 dp 5 results agree with expected trend **;** 6 at least one result is given as a range **;** 7 replicates recorded **;**	**[max 5]**
(f)	correct orientation of axes **;** *x*-axis = concentration of alcohol, *y*-axis = concentration of betalains axes scaled with ascending linear scale starting at 0,0 and covering at least half the grid **;** axes with correct titles and ref. to percentage **;** points plotted accurately to within half a small square **;** points joined clearly / neatly, by straight lines **;** **A** line / curve of best fit if supported by results line must not be extrapolated beyond data points	**[5]**

Question	Indicative Material	Mark
(g)	1 description of pattern from graph ; 2 use of comparative data from table and / or graph to illustrate ; 3 ref. to any or no anomalous results in the table / graph, with justification ; 4 ref. to result(s) in water / 0% alcohol ; e.g. any leakage in water needs to be taken into account when interpreting results from the alcohol solutions 5 betalains <u>diffuse</u>, out of vacuoles and cells / through tonoplasts and cell (surface) membranes ; 6 membrane remains intact up to critical concentration ; 7 permeability increases with alcohol concentration / AW ; 8 alcohol is, an organic / a non-polar, solvent ; **A** fats / (phospho)lipids are soluble in alcohol 9 disruption of, <u>hydrophobic</u> region / fatty acids / (phospho)lipid 'tails' ; 10 any plausible suggestion as to type of disruption ; e.g. hole formation 11 disruption of organisation / denaturation, of proteins in membranes ; 12 AVP ; e.g. ref. to cholesterol 13 AVP ; e.g. explanation of deviation from standard pattern alcohol acts faster at higher concentrations polar nature of, ethanol / alcohol	**[max 7]**

(h) Evaluation of procedures and data	
repeatability	no pilot experiment ;
	limited number of results for each concentration ; **A** ref. to number of replicates / 'should have been repeated'
	ref. to any anomalous result(s) ;
independent variable	not enough (intermediate) concentrations of alcohol ; **A** not enough concentrations of alcohol around the critical point
	idea that alcohol solution used is a mixture of ethanol and methanol, so cannot determine effect of each ;
dependent variable	*idea* that it is difficult to match colours ; **A** subjective / semi-quantitative'
	(some / all) colours were intermediate between colour standards ; **A** uneven intervals
	differences between colour standards or between results were difficult to distinguish ;
controlled variable – timing	no real time zero / takes time to add discs to tubes ;
	no exact end time as it takes time to pour off the solution ;
	idea that length of time for immersion can be too long to distinguish between concentrations of betalain ; or not enough time for alcohol to affect all the cells in each disc ;
other variables	pH, not controlled / not measured ;
	temperature not controlled ;
	ref. to removing water from the surface of the discs ;
	pigment, remains attached to discs / difficult to dislodge ;
	syringes are not very precise / large percentage error / explained / AW ;
	using apparatus provided difficult to cut uniform discs ;
	different densities of, colour / pigment, in different beetroots / parts of same beetroot ; **A** different beetroot used for standards and experiment
	ethanol / alcohol, evaporates so concentrations change ;
	cells damaged by, cutting / handling ;
	ref. to no standardised agitation of specimen tubes ;
	ref. to diffusion shells / discs not evenly exposed to solution, and effect on results ;
	ref. to 0% ; e.g. leakage occurs so results are all overestimates of effect of alcohol on membranes
use of figures / data in support	use of any results to illustrate any one of these points
	[max 7]

Question	Indicative Material	Mark
(i)	1 use an appropriate, filter / wavelength ; e.g. blue / 400–450 nm 2 that absorbs red light ; 3 zero colorimeter between readings with 100% alcohol (as a 'blank') ; **A** 'tare the colorimeter' 4 ref. to, stirring / agitating ; 5 take samples of alcohol at known intervals of time ; 6 filter / centrifuge, to remove, suspended matter / AW ; 7 put sample into, cuvettes / tubes, and place into colorimeter and take absorbance / transmission, readings ; 8 taking colorimeter readings with known concentrations of betalains ; 9 plot conversion graph ; 10 use graph to determine concentrations of betalains in water ; *11 either* calculate rate by dividing the change in concentration by the time elapsed or determine rate from, graph explained / tangent on a graph ; or determine rate from time taken to reach a, stated concentration of betalain / specific absorbance, and calculate 1 / time ; 12 ref. to rate changes over time / calculate initial rate ; 13 AVP ; e.g. use different tubes for each sampling time 14 AVP ; e.g. pour sample from cuvette back into solution	**[max 5]**
		[Total: 45]

Section B

Question	Indicative Material	Mark
2 (a)	*drawing marks:* drawing(s) with labels, fill(s) more than half the space available **;** outline drawn with clear, unbroken lines **;** drawing includes the petiole and at least two points to the lobes and main veins to points **;** *labels:* petiole **;** blade / lamina **;** mid-rib / vein(s) **;** appropriate magnification given **;** **A** scale bar	**[max 6]**
(b) (i)	*marks for one or more drawings to show characteristic features of the epidermis:* outlines drawn with clear, unbroken lines **;** cells shown in correct proportions and with correct shapes **;** drawing includes at least one stoma **;** different thickness of inner and outer cell walls of guard cells **;** chloroplasts in guard cells **;** *labels:* epidermal cells(s) **;** guard cell(s) **;** stomatal, pore / opening / aperture **;** **A** stoma / stomata chloroplasts **;** cell wall of guard cells **;**	**[max 6]**
(ii)	magnification correctly calculated from measurement given **;** use of eyepiece scale to measure stated distance on drawing **;** *explanation* calibration of, eyepiece scale / graticule **;** *maybe stated (as already known) and / or explained using stage micrometer*	**[3]**

Question	Indicative Material	Mark
(c)	*assume descriptions are about* Iris *unless told otherwise* 1 *Iris* epidermal cells are in straight rows ; ORA *C. muralis* epidermal cells not regularly arranged 2 *Iris* stomata are in regular arrangement / AW ; ORA *C. muralis* stomata are more randomly arranged / AW ; *If mp 1 or mp 2 is not given, award a mark for lower epidermis is (more) regular* 3 *Iris* epidermal cells are rectangular / long and thin / tapering / AW ; 4 *C. muralis* epidermal cells are like jigsaw pieces / AW ; 5 *Iris* pairs of guard cells are more rounded ; ORA *C. muralis* guard pairs are more elongated 6 different stomatal densities ; 7 different size of guard cells ; 8 *Iris* guard cells contain more chloroplasts ; 9 *Iris* stomata are at tapered ends of epidermal cells ; 10 *Iris* stomata are surrounded by four epidermal cells ; ORA *C. muralis* surrounded by different number of cells 11 any calculated, measurements / ratios, to illustrate a difference ;	**[max 6]**
		[Total: 21]

Question	Indicative Material	Mark
3 (a)	cell that divides by meiosis has, bivalents / homologous pairs / ORA ; **A** chromosome pairs	[1]
(b) (i)	16 ; 9 ; 64(%) ;	[3]
(ii)	13.5 ;	[1]
(iii)	first four rows correct ; row 5 shows correct division by expected number from row 2 ; chi-squared = 1.006 / 1.01 ; **A** ecf from **(b)(i)** and **(b)(ii)**	[3]
(iv)	there is no significant difference between the, observed / numbers of asci showing crossing over, and the expected number ;	[1]
(v)	1 ;	[1]
(vi)	ref. to *p* less than or equal to 0.05 ; critical value at 1 degree of freedom = 3.84 ; **A** ecf from **(b)(v)** **A** if circled in table chi-squared value is less than critical value ; **A** ecf from calculated chi-squared value in **(b)(iii)** no significant difference / null hypothesis is accepted ; **A** ecf from **(b)(iii)** and **(b)(v)** *p* is more than 0.10 (and less than 0.50) ; **A** ecf from **(b)(iii)** and **(b)(v)**	[max 4]
		[Total: 14]