CAMBRIDGE INTERNATIONAL EXAMINATIONS

Pre-U Certificate

MARK SCHEME for the May/June 2014 series

9790 BIOLOGY

9790/03 Paper 3 (Practical), maximum raw mark 80

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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Notes:
The following abbreviations may be used in mark schemes:

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

Section A

Question	Indicative Material	Mark
1 (a)	1 equilibrate yeast suspension by placing tubes in water-baths, until target temperatures reached / for greater than or equal to one minute ; 2 materials provided used to maintain the temperature of the water-bath(s) ; *must include use of a thermometer* 3 separate respirometers used for each temperature ; 4 temperatures / temperature range, given ; *must be five or more with minimum of 40 °C range* 5 ref. to at least one control variable ; *e.g. suspension stirred thoroughly before each sample is taken* *air bubbles removed from base of syringe (near nozzle)* *respirometers suspended <u>vertically</u> in a clamp* 6 glass tubing marked to indicate start (and end) position(s) for meniscus ; 7 several preliminary readings taken to ensure the movement of meniscus is constant ; 8 standardised method for taking readings ; *e.g. same length of time / same distance travelled* 9 ref. to replicates (from same respirometer or from different respirometers) ; 10 ref. to precision of readings for distance and time ; *e.g. reading position of meniscus carefully / ref. to parallax error* 11 ref. to any control(s) ; *e.g. yeast suspension without glucose* *glucose solution without yeast* *water without glucose or yeast* 12 rate of respiration calculated as distance / time *or* volume / time *or* 1 / t ; 13 AVP ; *any further precautions for setting up* *e.g. using a, pilot / trial, to see how long to time* *using a staggered start* 14 AVP ; *any way to improve taking of results* *e.g. start timer before meniscus passes 'start' line* *how to calculate volume of gas produced using $\pi r^2 h$*	**max 8**

Question	Indicative Material	Mark
(b)	1 data recorded as a single table with logical sequence of columns and rows **;** 2 informative column headings with correct units in column headings (temperature / °C and distance / mm and/or time / s) **;** **R** if units in the body of the table 3 results recorded to same degree of precision in each column **;** *i.e. data recorded as whole numbers or to same number of decimal places* 4 uncertainty shown in column headings (temperature and / or distance) **;** 5 *either* time recorded to the nearest second *or* to 0.1 s (not minutes and seconds) *or* distance recorded to nearest mm *or* 0.1 cm *or* to 0.5 mm **;** **R** if 0.01 mm / 0.01 s 6 anomalous results for replicates identified / any qualitative observations of the respirometers **;** 7 results show expected trend **;** 8 AVP **;** *e.g.* *actual temperatures shown rather than target temperatures* *temperatures at start and end of equilibration period* *multiple results after short periods of time (to work out a gradient)* *results for controls within main table or given separately*	**max 6**
	means calculated correctly and presented consistently **;** standard deviations calculated correctly **;** rates calculated with appropriate units given in column heading **;** *e.g.* $mm\,s^{-1}$ *or* s^{-1} all rates calculated to appropriate number of significant figures **;** **A** if different calculation used to the one given in **1 (a)**	**max 2**

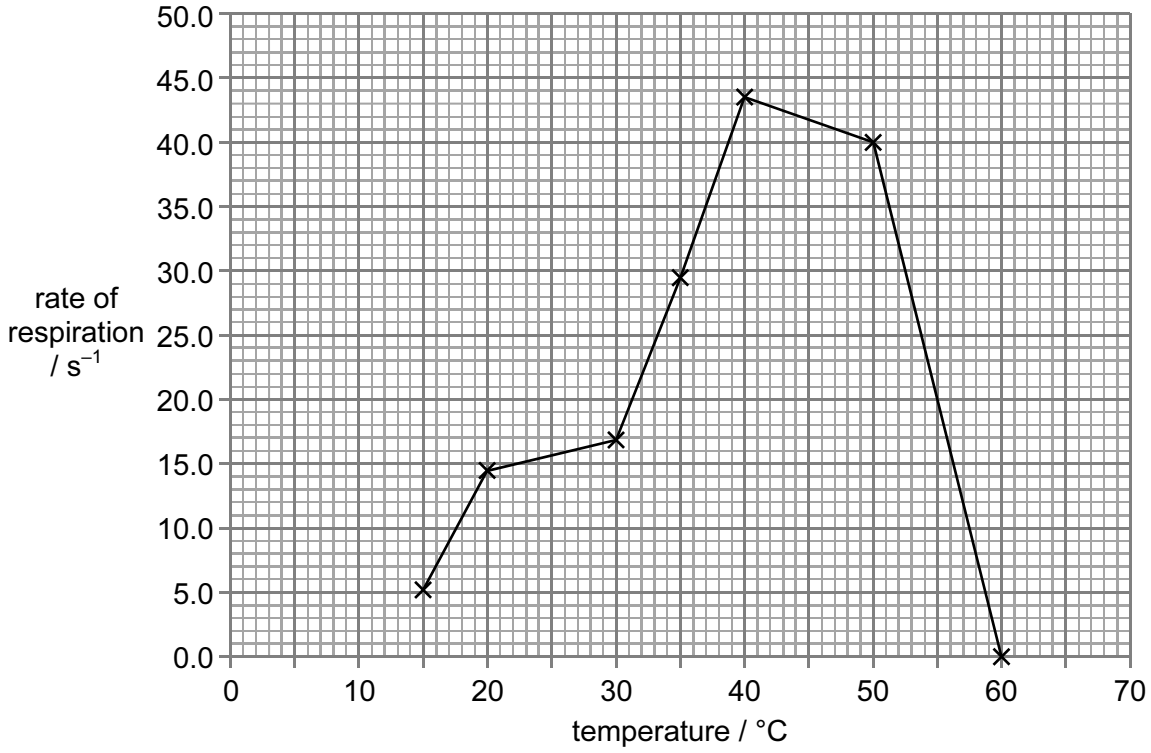
exemplar results table:

temperature / °C (±0.5 °C)	time taken for meniscus to move 100 mm / s				rate of respiration (1000/t) / s^{-1}
	1	2	3	mean	
15	174	220	no reaction	197	5.1
20	69	76	61	69	14.5
30	50	45	82	59	16.9
35	33	31	39	34	29.4
40	18	27	23	23	43.5
50	30	21	25	25	40.0
60	-	-	-	-	0
control at 35 °C – no glucose	-	-	-	-	0

shading = anomalous result

Question	Indicative Material	Mark
(c)	1 correct orientation of axes (*x*-axis = temperature, *y*-axis = rate of respiration) **;** **A** time *or* distance as ecf if rates not calculated 2 graph covers at least half the grid and axes scaled with ascending scale starting at 0,0 **;** **A** interrupted scale(s) **R** poor choice of scale, e.g. in intervals of 3 or multiples of 3 3 axes with correct titles and units **;** *e.g. rate of respiration / mm s^{-1} and temperature / °C* **A** ecf for units from table and time *or* distance with units if rate not calculated 4 all points plotted accurately **;** 5 quality of, line(s) / curve(s) **;** **R** if sketched / if line goes beyond last plotted point or to the origin if 0 °C was not included 6 AVP **;** *e.g. labelled line (or data point) for any control(s)* *use of range or error bars*	**max 5**

exemplar graph:



Question	Indicative Material	Mark
(d) (i)	carbon dioxide produced in, aerobic / anaerobic, respiration **;** the gas is responsible for increase in, volume / pressure, in the syringe (displacing the yeast suspension) **;** source is decarboxylation in, link reaction / Krebs cycle / anaerobic pathway **;** *if this is not given in **(d)(i)**, then credit if given in **(d)(ii)***	**max 2**
(ii)	*description:* 1 description of the pattern from the graph **;** *e.g. rate of respiration increases to a maximum and then decreases* 2 use of comparative key data from table and / or graph to illustrate **;** *e.g. ref. to rate at optimum temperature and rate at one other temperature* **R** if no units from graph / table, but allow ecf 3 ref. to Q_{10} **;** *e.g. rate doubles with 10 °C increase* 4 calculation of any value for Q_{10} from the data **;** 5 identification of any anomalous result(s) on the graph with justification **;** **A** 'there are no anomalous results' with justification *explanation:* 6 effect of high temperature on loss of stability of phospholipid bilayer **;** 7 ref. to increase in, kinetic energy / (successful) collisions between substrates and enzymes **;** **ignore** in context of yeast cells 8 denaturation of, enzymes / carrier proteins, at high temperature **;** **R** 'yeast is denatured' 9 ref. to carrier proteins in membranes *or* (named) enzyme(s) of, glycolysis / link reaction / Krebs cycle / anaerobic pathway **;** 10 breakage of (named) bonds maintaining, tertiary / quaternary, structure **;** **A** 3-D structure **R** peptide bonds 11 loss of shape of active site **;** *e.g. substrate can no longer fit into active site / active site is no longer complementary to substrate* 12 AVP **;** *e.g. explanation of controls* *rate of diffusion of oxygen into yeast cells* 13 AVP **;** *e.g. estimate of optimum temperature as within a range* **ignore** references to V_{max}	**max 8**

(e)
evaluation of procedures and data *to be assessed in the light of answers to* ***(a)***
A ideas for improving gas collection method
R different strategy, e.g. using redox indicator

identifying limitations and sources of error	suggesting improvements
reliability / repeatability	
results obtained from one sample of yeast **;** ref. to number of, replicates / repeats **;** **A** not enough / do more **R** 'there were no repeats' ref. to any anomalous result(s) in table / graph **;** **A** 'there are no anomalous results'	*if no replicates in* ***1(b)*** take at least three replicates and calculate a mean **;** replicates allow identification of anomalous results **;** take at least five repeats and calculate standard deviation **;** use standard deviation, for error bars / to indicate spread of results about the mean **;**
measurements	
error(s) in reading from the, mark(s) on tube / stopwatch **;** *e.g. mark too thick* stated difficulty with timing **;** reaction too, fast / slow **;** timings are underestimates (as stopwatch started after meniscus passes start line) **;** ref. to gas leaks (so distances may be underestimates) **;** tube too short with large % error **;**	use graduated tube **;** **A** use a light gate / sensor (and data logger) / AW use, lower / higher, concentration of yeast **;** use a thinner tube **;** use petroleum jelly / use a sealed unit **;** use alternative apparatus to measure gas **;** *e.g. gas syringe / carbon dioxide probe* use longer tube to minimise % error **;**
preparation	
air bubbles in respirometer **;** **A** ref. to foam	add anti-foam agent / AW **;**
respirometers set up at different times so concentration of glucose solution decreases **;**	use a fresh yeast suspension each time / use yeast suspension of same age each time **;** use glucose in excess **;**
difficult to standardise the volume of suspension in each respirometer **;**	use larger syringe with smaller percentage error in measuring volume **;**

evaluation of procedures and data *to be assessed in the light of answers to* ***(a)***
A ideas for improving gas collection method
R different strategy, e.g. using redox indicator

identifying limitations and sources of error	suggesting improvements
independent variable	
constant temperature not maintained ;	place respirometers in thermostatically-controlled water-bath / AW ; insulate syringe / use temperature probe to monitor changes inside syringe ;
temperature of suspension will change while setting up respirometer ;	warm up the respirometers before using them / any suitable suggestion ; set up and use the respirometers quickly ;
time not long enough to see effect of temperature on activity of yeast ; e.g. ref. to time taken for denaturation	leave suspensions in water-baths at target temperatures for longer / use trials to find best time for equilibration ;
uncontrolled variable	
pH not controlled ;	use a buffer solution / make up the suspension and / or glucose solution in a buffer solution ;
idea that ethanol is an inhibitor of respiration and its concentration increases with time ;	
oxygen concentration ;	shake / stir, sample of yeast and glucose to introduce oxygen to limit anaerobic respiration ;
results	
not enough temperatures ; **R** not high enough as should have planned this	more intermediate temperatures ; *must be stated temperatures within range used or beyond the range*
rate changes while results are taken ;	*idea that* results are taken at intervals and discard those not showing constant rate ;

AVP ;
AVP ;
for any other suitable limitations or improvements
e.g. use of control(s) for each temperature if not done
use of a pilot investigation with justification
appropriate statistical method such as correlation coefficient

max 8

Question	Indicative Material	Mark
(f)	*advantages:* using dip sticks allows yeast suspension to be kept at target temperatures ; instead of the yeast suspension cooling in the syringe barrels ; no problem with expansion of, gas / liquid, at higher temperatures ; no problems with gas leakage from gas collection apparatus ; can find out when the suspension has run out of, glucose / substrate ; easy / quick, to use ; **A** no skill needed *idea that* following the rate of reaction is easier than using a respirometer that needs resetting ; *disadvantages:* results using colours on dip sticks are subjective / high level of uncertainty ; **A** 'ambiguity' colours change after the test ; gaps between the different colours on the scale are irregular ; gaps between different colours on the scale are large ; colours for adjacent concentrations are very similar ; *e.g. 0.10 and 0.25, only 5 / 6 concentrations given* concentrations intermediate between those given on the scale have to be estimated ; colour chart shows that no discrimination at concentrations above 2 g 100 cm^{-3} ; **A** narrow range of concentrations gives concentration of glucose, in solution / not absorbed by yeast ; rate of uptake is not the rate of respiration ; enzymes in dip stick may be denatured at high temperature ; pH may affect, enzymes / dyes / substrates / products, in dip stick ; expensive as many are needed, to follow rate of reaction / for replicates ; **A** dip sticks cannot be reused AVP ; *accept any explanation or further detail of the above points* *e.g. chemicals released by yeast may interfere with the reaction in the pad on the dip stick* *quantities of glucose used by yeast may be very small and not detectable*	**max 6**
	Total:	**45**

Section B

Question	Indicative Material	Mark
2 (a) (i)	*low-power plan drawing of a muscular artery* *drawing:* 1 plan drawing (no cells) of suitable size to show arrangement of tissues **;** 2 clear, unbroken lines with no shading or hatching **;** 3 near concentric lines to show tissues in correct proportions with tunica intima + tunica media being wider than tunica adventitia, wavy line for tunica intima, lumen is large in proportion to wall **;** *labels:* 1 endothelium **;** 2 tunica, intima / interna, and tunica media **;** 3 internal and external elastic laminae **;** 4 tunica, adventitia / externa / AW **;** 5 lumen **;**	**max 7**
(ii)	*high-power drawing of part of the wall of a muscular artery* *drawing:* 1 sector of the wall of **K1** / drawings from each layer **;** 2 appropriate size to show details with tunica media thicker than tunica adventitia **;** 3 elastic fibres drawn thinner than collagen fibres **;** *labels:* 1 endothelium **;** 2 elastic fibres (in tunica intima and/or tunica media) **;** 3 <u>smooth muscle</u> **;** **A** circular muscle 4 collagen fibres (in tunica adventitia) **;** 5 vasa vasorum / red blood cells **;** **ignore** nuclei in the wall	**max 7**
(iii)	magnification given **;** *calculated from a dimension (width / length) recorded on drawing corresponds with size of drawing and measurement in eyepiece graticule units (epu) from slide as given in **(a)(iv)** or on drawing* **R** magnification derived by multiplying magnification of eyepiece by magnification of objective lens (e.g. × 400)	**1**
(iv)	*explanation:* calibration of, eyepiece scale / graticule **;** 1 epu = 2.5 μm at ×400 use of eyepiece scale to measure stated distance on artery **;** *e.g. 70 – 80 epu = 175 – 200 μm* *maybe stated (as already known) and/or explained using stage micrometer*	**2**

Question	Indicative Material	Mark
(b)	*data presented in one table with headings K1, K2, K3 or names of blood vessels* direct comparisons made **;** *e.g. by using a column for features* *similarities between the three vessels to max 2* *differences to max 8* overall shape or shape of lumina **;** qualitative comparison of sizes **;** diameters of blood vessels with appropriate units **;** diameters of lumina with appropriate units **;** relative wall thicknesses of wall relative to overall diameter **;** wall:lumen ratios **;** relative quantity of (smooth) muscle **;** relative quantity of elastic tissue **;** relative quantity of fibrous tissue **;** dominant colours of staining **;** blood inside veins, less / none, inside arteries **;** AVP **;** AVP **;** *e.g . measurements of tissue layers to max 2* **R** rough / smooth inner wall *or* lining	**max 8**

Question	Indicative Material		Mark
(c)	*mark labels and annotations independently*		
	labels to max 4	*annotations to max 4*	
	lumen (of capillary) ;	ref. to pressure of blood ; ref. to contents of blood and filtration ;	
	endothelium (of capillary) ; **A** capillary wall / squamous epithelium	ref. to ultrafiltration ;	
	fenestrations / AW, in endothelium ;	reduces resistance for filtration ;	
	basement membrane ; **ignore** thin	acts as filter allowing water and small solutes to leave the blood / retain large solutes *or* cells ; ref. to RMM of substances filtered from blood ;	
	podocyte ; pedicel(s) ;	supports capillaries ;	
	slit pores / gaps between processes of podocytes ;	reduce distance for filtrate to travel ; reduce resistance for filtration ;	
	Bowman's, capsule / space ;	collection of filtrate (before entry to proximal convoluted tubule) ;	
	plasma / nucleus / cytoplasm *or* plasma / cell surface, membrane ;		
	AVP ; *e.g. width of lumen = 10 μm*		**max 8**

Question	Indicative Material	Mark
(d)	(together with cross-section) gives three dimensional structure **;** ref. to valves (in veins) **;** ref. to branching / see where vessels originate from / AW **;** see how, lumen / thickness of wall, varies along the length of the vessel **;** see variation of thickness of (named) layers along the vessel **;** *idea that* can see more than one endothelial cell of a capillary **;** see full dimensions of, fibres / longitudinal muscle **;** extent of any damage **;** *e.g. plaque / atheroma* **R** see surface of endothelium	**max 2**
	Total:	**35**