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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2011 question paper for the guidance of teachers

9700 BIOLOGY

9700/31 Paper 3 (Advanced Practical Skills 1), maximum raw mark 40

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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Mark scheme abbreviations:

;	separates marking points
/	alternative answers for the same point
R	reject
A	accept (for answers correctly cued by the question, or by extra guidance)
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants excepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
ACE	Analysis, Conclusions and Evaluation (skills)
MMO	Manipulations, Measurement and Observation (skills)
PDO	Presentation of Data and Observations (skills)

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1 (a)			[3]
MMO decisions 3	mp1	(labels under correct sequence of beakers) 0.025 **AND** 0.0125 **AND** 0.00625;	
		Additional guidance	**Must have** % once and concentrations to 3 or more decimal places **A** mixture of precision e.g. 0.025 with 0.012 or 0.013 with 0.006 or 0.0062 or 0.0063
	mp2	**EITHER** (uses serial dilution)	
		10 cm^3 of 0.05(%) or shown by arrow with 10 cm^3 **AND** 10 cm^3 transferred from third beaker to fourth and from fourth beaker to fifth beaker;	
		Additional guidance	**Must have** cm^3 once in either and or % once when labelling or **ecf** if mp1 not given
	mp3	(adds (distilled) water / **W** to **each** of three beakers BUT **MUST** add previous concentration to fourth and fifth beakers) 10 cm^3 (into each beaker $3^{rd}/4^{th}/5^{th}$) of (d) W or water;	
		Additional guidance	**Must have** cm^3 once **ecf** if mp1 not given and / or if mp2 not given

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max 1

OR (simple dilution for mp1 and mp3)

0.1% (**S**)	2.5 AND	**AND**	1.25 AND	**AND**	0.625 AND
W	7.5		8.75		9.375

OR

0.1% (**S**) **W**	5.0 AND 15.0	**AND**	2.5 AND 17.5	**AND**	1.25 AND 18.75

Additional guidance

Must have cm^3 once and 10 (%) for each beaker with % once or arrow from first beaker to each one
ecf if mp1 not given
R if

- round volumes up or down
- just **S**

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	(ii)		**[5]**
PDO recording 2	[1]	table with all cells drawn **AND** heading (top or left) percent(age) conc(entration) ;	
		Additional guidance	**A** no outer boundary **A** % **R if** % in body of table **Ignore** test-tube / additional columns
	[1]	(heading below or to right) time sec(onds)/s; **R** T or t	
		Additional guidance	**R if** units in body of table
MMO collection 2	[1]	records times for at least four concentrations;	
		Additional guidance	**A** any times as long as with clear units. **Must have** cm^3 once **ecf** if mp1 not given for slip and / or if mp2 not given
	[1]	any times as whole seconds (numbers) 'less than 601' ;	
		Additional guidance	**A** minimum of four recorded times including 'more than 600'.
MMO decision 1	[1]	records correct pattern: highest concentration recorded is shorter time than next concentration;	
		Additional guidance	**A** any values, e.g. seconds with tenths or min:sec **A** minimum two recorded times including 'more than 600' once

	(iii)		**[1]**
	Mark first variable.		
ACE improvement 1	[1]	temperature **AND** thermostatically controlled water-bath / AW;	
		Additional guidance	**R** pH **A** digital or electronic **A** description of use of heating and cooling with Bunsen or hot and cold water

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(iv)			**[max 2]**
Mark the first three ideas for two correct.			
ACE improvement 2 **max 2**	**max 2**		
	mp1	(independent variable) more / different / vary / wider range concentrations / solutions;	
	mp2	two examples of different concentrations;	
		Additional guidance	**A** mp1 and 2 if list at least two more concentrations between correct values or examples of smaller intervals or implies all differences e.g. 0.5% **R** 'serial dilution'
	mp3	use a colorimeter or use a pH meter or indicator paper or use a colour standard;	
	mp4	(dependent variable) (repeat / replicate) more than once / many / more times / twice / thrice;	
		Additional guidance	**A** doing repeats / replicates / repetitions

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(b) (i)			[4]
PDO layout 4	O	*x*-axis concentration of inhibitor / μg cm^{-3} **AND** *y*-axis inhibition area / mm^2	
		Additional guidance	**Must have** units on *x*-axis AND *y*-axis
	S	scale as *x*-axis 20 to 2 cm **AND** *y*-axis 20 to 2 cm ;	
		Additional guidance	**ecf** if no labels for O if reverse O then scale must use more than half grid for both x and y and do not have an awkward scale **A** no 0 label at origin and no end label
	P	correct plotting of each point to within half a square;	
		Additional guidance	**A** small cross or dot in circle or cross in circle **A ecf** if *x*-axis not 0 if scale 20 to 2 cm even **R if** • plot 100 with same cross or dot in circle • awkward *y*-axis scale • blobs or dots alone • cross too large
	L	ruled lines point to point or curve through all points **AND** quality clear sharp; **R if** • less than 5 plots • line 1mm or thicker • any feathery line • irregular thickness • any extrapolation	
		Additional guidance	**A ecf** from incorrect P

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	(ii)		**[1]**
ACE interpretation 1	[1]	reading is shown at <u>100</u> **AND** correct concentration of inhibitor;	

	(iii)		**[2]**
ACE interpretation 2	[1]	as <u>concentration</u> increases the <u>inhibition</u> (area) increases;	
		Additional guidance **Ignore** (inversely / directly) proportional	
	[1]	inhibition slows down;	
		Additional guidance **A** levelling off or plateau or decreasing rate **R** stops going up / increasing	

	(iv)		**[2]**
ACE conclusion 2	[1]	*(rate of)* hydrolysis *or breakdown or digestion would slow down*;	
		Additional guidance **A** (enzyme) bonds broken or denatures	
	[1]	*Idea of (at higher concentrations)* more active sites inhibited / describe *or* shape of active site / enzyme changed or fewer ES complexes (formed);	
			[Total: 20]

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2 (a) (i)		**[5]**
PDO layout 1	[1]	no shading **AND** *longer than 60 mm in any direction* **AND** (clear, sharp, unbroken lines) **Must have** four or more hand drawn lines and / or enclosed areas **R if** • drawn over the print of question • any line 1mm or thicker • any feathery line • three 'tails' or overlaps or gaps • **any** ruled or dashed line
MMO collection 2	[1]	no cells drawn **AND** whole quarter drawn **AND** at least one enclosed area;
	[1]	(epidermis) drawn with two lines closer than 4 mm at widest point **AND** four and nine complete air spaces;
PDO recording 1	[1]	shows two / three distinct regions from centre;
MMO decision 1	[1]	correct label with one label line to epidermis;
		Additional guidance **R if** • any label which is biologically incorrect e.g. from incorrect organ e.g. spongy mesophyll or animal e.g. epithelium or cell structures • any label within drawn area

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	(ii)	[5]
PDO layout 1	[1]	no shading **AND** largest dimension of one cell larger more than 40 mm in any direction **AND** (clear, sharp, unbroken lines for outer cell line only); **Must have** three or more hand drawn enclosed areas **R if** • drawn over the print of question • any line thicker 1 mm or thicker • any feathery or broken/dashed line • any 'tails' or overlaps or gaps if two lines for cell walls • any ruled lines
MMO collection 3	[1]	drawn three cells touching and forming a single chain;
		Additional guidance **R if** any ruled lines
	[1]	one cell tapers to join one adjacent cell **AND** this cell is the largest;
		Additional guidance **R if** any extra line (basal line) **R if** incorrect cell organelles such as golgi, mitochondria etc.
	[1]	cells walls as double lines with middle lamella between each pair of adjacent walls;
MMO decision 1	[1]	correct label with one label line to a cell wall;
		Additional guidance **R if** any label other than cell wall **R** any label within drawn area

	(iii)	[1]
	Mark first feature.	
ACE conclusion 1	[1]	(air) spaces for floating / buoyancy / support / flexibility **OR** chains of cells for support / gas exchange / AW;

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(b)	**(i)**		**[4]**
MMO collection 1	[1]	five *(measurements)* all between 10 and 40	
		Additional guidance **A** 1 to 4 **A** to 0.5 mm only and to 0.05 cm only	
MMO decision 1	[1]	*(10 to 40) mm OR (1 to 4) cm*;	
PDO display 2	[1]	shows addition step **AND** shows division by no. of measurements shown;	
	[1]	shows multiplication by *1000 / 10^3 for mm or 10000 / 10^4 for cm* ***AND*** *shows division by 30*;	
		Additional guidance **ecf** for incorrect measurements **R** any ref. to metres	

	(ii)		**[5]**
PDO recording 1	[1]	organise as a table / Venn diagram / ruled boxes **AND** headed **J1** and **Fig 2.2** **AND** first difference opposite each other;	
MMO decision 1	[1]	only **one** observable similarity recorded AND only **two** differences;	

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ACE interpretation **max 3**

max 3

	feature	J1	Fig. 2.2
mp1	**Similarities**	spaces or vascular bundle(s) or chains of cells;	
mp2	*central stele* *vascular bundle*	*present* *centre*	*absent;* *scattered or periphery;*
mp3	*air space shape* *arrangement*	*triangular* *regular or symmetrical*	*circular/oval;* *irregular/random or not symmetrical;*
mp4	*air space number* *area*	*more* *less of small(er)*	*few;* *more or large(r);*
mp5	*projections into air space*	*none*	*spiky projections;*
mp6	*each air space sizes*	*similar/same*	*different or vary or large and small;*
mp7	*epidermis*	*thin*	*thick;*
mp8	*cells* *cell shape*	*large(r) or more* *packed or more* *vary or different*	*smaller or loosely packed or few(er)* *same or less different;*

Additional guidance **Ignore**

- tick and cross without a key
- diagrams
- refs. to size
- 3-D descriptions such as spherical
- colours / staining

[Total: 20]

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1 (a) (i)			[3]
		Do not give marks mp2 and mp3 for simple dilution	
MMO decisions 1	[1] mp1	labels under correct sequence of beakers <u>0.5</u>(%) **AND** <u>0.05(</u>%) **AND** <u>0.005(</u>%);	
		Additional guidance **Must have** % once	
MMO decisions 2	[1] mp2	**Must be** serial dilution (**R** if simple dilution) and adds previous concentration of milk (**M**) to **each** of three beakers and 1 cm^3 (adds previous concentration of **M** to **each** of three beakers and 1 cm^3) **EITHER** 1 cm^3 on an arrow from each previous beaker to next **OR** <u>1</u> cm^3 of <u>5</u>(%) (to 3rd beaker) **AND** <u>1</u> cm^3 of <u>0.5</u> (%) (3rd to 4th beaker) **AND** <u>1</u> cm^3 of <u>0.05</u> (%) (4th to 5th beaker);	
		Additional guidance **Must have** cm^3 once in either and or % once when labelling or **ecf** if mp1 not given	
	[1] mp3	(adds (distilled) water / W to **each** of three additional beakers but **MUST** add previous concentration to fourth and fifth beakers) <u>9</u> cm^3 (into each beaker 3rd / 4th / 5th) of (d) <u>W or water</u>;	
		Additional guidance **Must have** cm^3 once **ecf** if mp2 not given	

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	(ii)	**[5]**
PDO recording 2	[1]	table with cells drawn **AND** heading (top left) percent(age) conc(entration) ;
		Additional guidance **A** no outer boundary **A** % **R** % in body of table **R** other units e.g. mol dm^{-3}
	[1]	(headings) colour OR observation(s) **AND** number or no or # or scale;
		Additional guidance **R** headings for standardised variables e.g. volumes **Ignore** heading for test-tubes or additional observations
MMO collection 3	[1]	records results for **any 5 different** concentrations **and U** (ignore position) **and W / 0**;
		Additional guidance **A** colours or numbers or only whole numbers
	[1]	records their highest concentration as highest <u>number</u> **AND** records next lower concentration next highest <u>number</u>;
		Additional guidance **Must have** at least two readings other than **U** **A** any values 10 or below **A** scale numbers in incorrectly headed column/row
	[1]	records collection of **EITHER** (for W) <u>blue or no purple</u> **AND** <u>0</u> **OR** records replicate; **A** scale numbers in incorrectly headed column / row

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(iii) **[2]**

MMO decisions 2

[1] *(from their results)* puts **U** in correct position on scale;

Additional guidance

50	5	(0).5	(0).05	(0).005
18	1.8	0.18	0.018	0.0018

10 → lower
darkest purple → blue

A ecf from different concentrations
R if shows values in wrong order from their results
R no value for **U** in results

[1] (from their result for **U**) correct quantity to complete the statement 'between ... and ... ' as

Additional guidance **A ecf** from different concentrations

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	(iv)		**[max 3]**
ACE interpretation 2	mp1	(independent variable) Idea of use or (repeat with) more concentrations between <u>two examples</u> of concentrations used -50% and 0;	
		Additional guidance	**Ignore** just wider / higher / lower **ecf** from answer to **(a)(ii)** or **(a)(iii)** if **U** more than 50%
	mp2	Gives **two** examples / figures relevant **EITHER** to their estimate **OR** between 50% and 0 OR description of use of e.g. colorimeter readings to draw a calibration graph and read off estimate;	
		Additional guidance	**ecf** if recorded **U** is above 50% then allow two examples more than 50% for mp1 and mp2 **R** if examples not in correct range e.g. more than 50% when **U** not recorded more than 50%
ACE interpretation **max 1**	mp3	(dependent variable) use colorimeter or colour standard card for colours **and** numbers; **R** cAlorimeter **R** white card or tile (since this is given)	
	mp4	replicate or repeat **U**;	
		Additional guidance	**A** more times / trials / readings or repeats or repeat **Ignore** mean **Ignore** repeat with different concentrations
	mp5	(standardised variables) use graduated pipette or syringe with smaller divisions or burette or measuring cylinder (as milk is too thick for syringe)	

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(b) (i)		[4]
PDO layout 4	O	*x*-axis <u>time</u> (/) <u>s or sec</u>(onds) **R** T or t **AND** *y*-axis <u>conc</u>(entration) <u>of protein</u> (/) <u>mg dm^{-3}</u> ; **R** mg/dm^{-3} **A** mg/dm^{3}
		Additional guidance **Must have** units on *x*-axis and *y*-axis
	S	scale as *x*-axis <u>10 to 2 cm</u> **AND** *y*-axis <u>20 to 2 cm</u> ;
		Additional guidance **ecf** if no labels for axes If reverse then scale must use more than half grid for both *x* and *y* and **not** have an awkward scale. If move origin from 0 **must label value** at origin. **A** no 0 label at origin and no end label **R** awkward scale
	P	correct plotting of each point to <u>within</u> half a square i.e. less than 1 mm from intersection;
		Additional guidance **A** small cross or dot in circle or cross in circle **A ecf** if *x*-axis not 0 if scale 20 to 2 cm even **R if** • awkward *y*-axis scale • blobs or dots alone • cross too large
	L	<u>ruled</u> lines point to point or <u>ruled</u> line of best fit (two plots on line and then 2 and 1 either side of line) **AND** quality clear sharp; **A** extrapolation from line of best fit to vertical or horizontal lines of plotted point only **R if** • less than 5 plots • line 1mm or thicker • any feathery line • irregular thickness • extrapolated when point to point line
		Additional guidance **A ecf** from incorrect P

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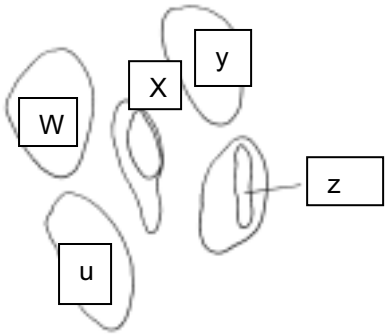
	(ii)		**[3]**
ACE interpretation 1	mp1	longer time (to collect) less protein present as time increases the concentration decreases **OR** shorter time more protein present as time decreases the protein concentration increases;	
		Additional guidance **Ignore** (inversely/directly) proportional	
ACE conclusions 2	mp2	Idea of (longer time in contact or to collect) <u>protease or enzyme</u> hydrolyses or digests or breaks down protein;	
		Additional guidance **R if** in context of change in concentration **Ignore** beads	
	mp3	(longer time) idea of ref. ES complexes or described OR (more likely) ref active sites used; (shorter time) idea of ref ES complexes or described OR (less likely) ref active sites used;	
		Additional guidance **R if** protein used again **R** enzyme all used up	

	(iii)		**[2]**
ACE interpretation 2	[1]	0.5 divided by / 15 multiplied by × 100;	
	[1]	correct answer; **ecf** for 1 /15 × 100	
			[Total: 22]

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2 (a)		**[5]**
PDO layout 1	[1]	no shading anywhere **AND** width across lines forming outer layers (convex surface) or largest enclosed area longer than *20 mm* **AND** (clear, sharp, unbroken lines); **Ignore** spaces drawn in innermost layer or enclosed areas outside lines **Must have** three or more hand drawn lines either with at least one folded **or** wavy line or may include at least one enclosed area to be assessed. **R if** • drawn over the print of question • any line 1mm or thicker or ruled • any feathery or broken / dashed • 2 'tails' or overlaps in line • 3 'tails' or overlaps with a enclosed area any ruled lines
MMO collection 2	[1]	no cells drawn **AND** only one field of view **AND** with at least one line folded or wavy or if no folds / wave but at least one enclosed area;
		Additional guidance **Ignore** (folds) enclosed areas within layers
	[1]	drawn at least five ridges / peaks / furrows / folds / waves in one line;
PDO recording	[1]	at least three folded or wavy lines **OR** drawn (spaces in innermost layer) as irregular (enclosed) areas **OR** one large enclosed area drawn with at least two lines;
MMO decision 1	[1]	correct label **D** with label line to **EITHER** between two folded or wavy lines or touching one of folded or wavy lines **OR** if enclosed area with two lines then inside this layer or to outer line;
		Additional guidance **R** any other label **R** any label within drawn lines

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(b) (i)		[4]
PDO layout 1	[1]	no shading **AND** largest nucleus more than 30 mm at longest point **AND** (clear, sharp, unbroken lines on outer membranes **only**) **Must have** three or more hand drawn enclosed areas **R if** • drawn over the print of question • any line 1mm or thicker or ruled • any feathery or broken/dashed line • any 'tails' or overlaps or gaps if **three** or fewer enclosed areas • 2 'tails' or overlaps or gaps if **four or five** enclosed areas
MMO collection 2	[1]	five whole nuclei drawn as in Fig. 2.1;
		Additional guidance **R** double line for outer boundary / nuclear membrane **R** additional diagrammatic organelles or chromosomes
	[1]	two nuclei are drawn with nucleolus (in nuclei shown by *x*, *y*, or *z* in guidance diagram below)
		ignore *contents of u, w, and y*
		guidance diagram: 
MMO decision 1	[1]	correct label with label line to one nucleolus in *x*, *y* or *z* only;
		Additional guidance **R if** • if label more than one • any label is biologically incorrect e.g. from incorrect organ or cell organelles such as Golgi or mitochondria • any label within or overlapping drawn nucleus

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	(ii)		**[3]**
MMO collection 1	[1]	measures line **L** correctly in mm; 14 or 14.5 or 15 or 15.5 or 16 or 16.5 mm;	
		Additional guidance	**A** 1.4 or 1.45 or 1.5 or 1.55 or 1.6 or 1.65 cm **Must have** units somewhere **Ignore** use of metres
PDO display 2	[1]	shows conversion mm to μm by multiplication ×1000 or 10^3 **OR** cm to μm by multiplication × 10 000 or 10^4;	
		Additional guidance	**A** conversion after division / incorrect measurement as long as units correct with correct conversion **R if** metres anywhere **R if** no units
	[1]	shows division of a number;	
		Additional guidance	**ecf** if measurement or conversion incorrect

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(c) (i) **[5]**

Mark first **three** in first column.

PDO recording 1 [1] organise as a table / Venn diagram / ruled boxes **AND** headed Fig.2.2 and Fig 2.3 **AND** first difference opposite each other;

MMO decision 1 [1] only **three** observable differences recorded;
R if any similarities

ACE interpretation max 3 **max 3**

	feature	Fig. 2.2	Fig. 2.3
mp1	(E layer) surface	rough or wavy or perforated	smooth or plain;
mp2	*(taste buds or cells or nuclei)*	visible or present/has/yes	not seen or absent/no(ne);
mp3	*overall shape/E/* ***R if** 3-D e.g. spherical* ***R** villi* ***A** calculated sizes*	(outer shape) folds or fingers or flat or elongated (projections or lumen) deep(er) or long(er) or large(r) or higher	 rounded or circular or curved; (projections or lumen) shallow(er) or short(er) or small(er) or lower;
mp4	*(E or L layer)* *(inner shape)*	folded or like fingers inside fold or goes deep	no folds inside; on surface;
mp5	*(L layer)*	thin(ner) or less or narrow(er)	thick(er) or more or wide(r);
mp6	*overall size or **E (and L)** layer* ***A** calculated sizes*	large(r) or thick(er or wide(r))	small(er) or thin(ner) or narrow(er);
mp7	*different layer at base of fold*	*absent or no(ne)*	*present or yes;*

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		Additional guidance **Ignore** • tick and cross without a key • diagrams • refs. to size • 3-D descriptions such as spherical • colours / staining

	(ii)	**[1]**
ACE conclusion 1	[1]	folds or ridges or projections or villus / villi or elongated or long and thin or long spaces taste bud(s) **AND** idea of large surface area *idea of* moves slower or traps liquid shape or many or both sides or all round;
		Additional guidance **Must have** feature and 'how'
		[Total: 18]

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1 (a) (i) **[3]**

MMO decisions 3

[1] two correct dimensions;

Additional guidance **R** any above 1 cm and any below 0.20

[1] one correct surface area with one correct volume;
If more than two then mark only first two.

Additional guidance **Must have** dimensions between 1 and 0.20 cm

[1] one correct surface area : volume ratio according to dimensions of agar blocks;
If more than two then mark only first two.

Additional guidance **Must have** dimensions between 1 and 0.20 cm

	SA	VOL	SA:VOL
1 × 1 × 1	6.0	1/0	6:1
1 × 1 × 0.5	4.0	0.5	8:1
1 × 0.5 × 0.5	2.5	0.25	10:1
1 × 1 × 0.25	3.0	0.25	12:1
0.5 × 0.5 × 0.5	1.5	0.125	12:1
1 × 0.5 × 0.25	1.75	0.125	14:1
0.5 × 0.5 × 0.25	1	0.0625	16:1
1 × 0.25 × 0.25	1.125	0.0625	18:1
1 × 1 × 0.4	3.6	0.4	8:1
1 × 1 × 0.2	2.8	0.2	14:1

SA = ((length × width) + (length × height) + (height × width)) × 2

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	(ii)		**[5]**
PDO recording 2	[1]	table with cells drawn **AND** heading (top or left) surface area to volume (ratio);	
		Additional guidance	**A** no outer boundary **A** SA:Vol(ume) **A** mean to left **R** V or v **R** if any units are included with surface area:volume ratio
	[1]	(heading) time / min(utes);	
		Additional guidance	**R** units in cells of column / row **R** secs / s or m **R** additional columns: surface area or volume with surface area:volume ratio **A** dimensions
MMO collection 2	[1]	records in whole minutes **AND** times for three blocks of each size **AND** either in order of increasing size OR shortest time to reach end-point to longest time to reach end-point;	
		Additional guidance	**R** whole seconds
	[1]	correct pattern of results – 6:1 (1 × 1 × 1 (6)) is the longer time than 8:1 (1 × 1 × 0.5 (4);	

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MMO decision 1	[1]	includes mean or average;	
		Additional guidance	**R** if no data **Must have** at least two sets of data

(iii)			**[2]**
Mark first **three ideas** for two correct.			
ACE interpretation **max 2**	**max 2**	Cause of error	WITH idea of error
	mp1	(independent variable – surface area:volume ratio) cutting / measuring blocks to size	difficult to be accurate or not straight / uneven or vary / not same / different;
	mp2	(dependent variable) number of blocks or three blocks	hard to record or difficult to judge time varies / different or variable;
	mp3	end-point	not easy to distinguish / sometimes not equal distance to see through or difficult to judge;
	mp4	(standardised) blocks	float to side / stick to bottom / blocks close together (diffusion hindered);
	mp5	blocks	different quantities of dye / different colours or too dark or unevenly distributed;

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(b) (i) **[3]**

Mark first four ideas for three correct. Note that dependent variable should not be controlled so ignore ref. to video camera or count for seconds and multiply.

ACE improvements **max 3**	**max 3**		
	mp1	(independent variable) (temperature of) fish	leave fish before counting allow to acclimatise to water in beaker before starting to count;
	mp2	(standardised variables) fish used **R** species or same fish	 keep the same / similar size / mass / weight / sex / age; same conditions before using
	mp3	fish moving about varies ref. to plastic bag **R** same beaker.	so restrict movement in small container, AW same bag or same type;
	mp4	oxygen content (of water) or temperature	so bubble oxygen through water or use running water;
	mp5	water / same volume	use same source / measuring cylinder graduated (beaker / pipette) / syringe;
	mp6	temperature of water **R** thermostatically controlled water-bath.	insulate beaker or fridge or water-bath with hot and cold / ice;

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	(ii)		**[4]**
PDO layout 4	O	*x*-axis temp(erature) °C **AND** *y*-axis rate of breathing number min^{-1};**A** bar chart	
		Additional guidance	**Must have** units for both axes **R** t or T
	S	scale as *x*-axis 5 to 2 cm **AND** *y*-axis 10 to 2 cm;	
		Additional guidance	**ecf** if no labels for O If reverse O then scale must use more than half grid for both *x*-axis and *y*-axis **A** no 0 label at origin **R** awkward scale
	P	correct plotting of each point to half a square i.e. 1 mm from intersection; **A** bar chart	
		Additional guidance	**A** small cross or dot in circle or cross in circle **R if** • awkward *y*-axis scale • blobs or dots alone • cross too large
	L	lines point to point or line of best fit **AND** ruled, clear sharp ruled lines thinner than half square; **A** extrapolation from line of best fit to vertical or horizontal lines of plotted point only	
		Additional guidance	**A ecf** from incorrect *P* **R if** • any feathery line • irregular thickness • extrapolation to zero

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	(iii)	**[3]**
ACE interpretation 1	[1]	**mp1** as temperature increases the rate of breathing increases; Additional guidance **ora** (directly) proportional / use of data if relationship clear e.g. from 10 to 25 rate of breathing increases
ACE conclusions **MAX 2**	[1]	(fish breathes quicker) **ora** **mp2** idea of more oxygen needed / used / required or less at lower temperatures OR **mp2** less oxygen in water;
	[1]	(as temperature increases <u>reason why it needs more oxygen</u> or at low temperatures why less oxygen needed) Ref to any increase of process in the fish **ora** **mp3** e.g. temperature of fish increases / rises or blood flows quicker or muscles work OR **mp3** fish moves more OR **mp3** enzymes or respiration work faster, (fish breathes faster) **mp4** (less oxygen) breathes faster to get required oxygen;
		[Total: 20]

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2 (a) (i)			[5]
PDO layout 1	[1]	no shading **AND** larger than 60 mm in any direction **AND** (clear, sharp, unbroken lines); **Must have** three or more enclosed areas **R if** • drawn over the print of question • any line 1 mm or thicker • any feathery or dashed line • 2 'tails' or overlaps or gaps • any ruled lines or compass drawn	
MMO collection 2	[1]	no cells drawn **AND** whole section **AND** (lumen) 'D'-shaped (not circular);	
	[1]	cartilage discontinuous;	
PDO recording 1	[1]	at least 6 lines across one wall **AND** irregular / rough innermost line;	
		Additional guidance **Ignore** additional enclosed areas outside main trachea	
MMO decision 1	[1]	correct label with label line to space between two lines to cartilage;	
		Additional guidance **R** any label which is biologically incorrect e.g. from incorrect organ or animal / plant **R** any label within drawn area **R** label line to a line **R** to innermost or outermost layer if no context (e.g. only two layers)	

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(ii)			**[5]**
		Ignore cilia or small inclusions.	
PDO layout 1	mp1	no shading **AND** length of smallest cell larger than 60mm in any direction excluding cilia **AND** (clear, sharp, unbroken lines); **Must have** three or more enclosed areas **R if** • drawn over the print of question • any line 1mm or more • any feathery line • 1 'tails' or overlaps or gaps • any ruled lines	
MMO collection 2	mp2	only two epithelial cells drawn and touching each other;	
		Additional guidance **Must be** touching along whole length of cells **R** two lines drawn for cell membrane	
	mp3	one nucleus per cell **AND** length of <u>both</u> nuclei greater than 25% of total length of cell, excluding cilia;	
MMO decision 2	mp4	EITHER at closest point between two nuclei within 7 mm;	*OR* if drawn top nucleus displaced towards middle of cell and shape tapers;
	mp5	correct label with label line to one epithelial cell **AND** one nucleus in correct context;	
		Additional guidance **R if** • drawn cell organelles e.g. mitochondria or Golgi • any label is biologically incorrect e.g. from incorrect organ or animal or plant e.g. epidermis • label within drawn area **Ignore** microvilli or goblet cells	

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	(iii)	[1]
ACE conclusion 1	[1]	(micro)cilia used to move / waft / sweep / swipe / carry / transport / remove / AW, mucus / dust / particles / substances / impurities / AW; NOT microvilli
		Additional guidance **Ignore** ref. to goblet cells / bacteria / lumens

(b)	(i)	[5]
PDO recording 1	[1]	organise as a table / Venn diagram / ruled boxes **AND** headed Fig. 2.1 and Fig. 2.2 **AND** first difference opposite each other;
MMO decision 1	[1]	only one similarity and only two observable differences recorded;

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ACE interpretation **max 3**

max 3

	feature	Fig. 2.1	Fig. 2.2
mp1	both have	cilia / nuclei / nucleoli / lumen / cells longer than wide / same length;	
mp2	length of cilia hairs length of cell (no cilia)	long(er) short(er) smaller	short(er) long(er) larger (more) elongated;
mp3	cilia hairs	continuous / complete not closely packed / not close	discontinuous / not complete closely packed or close;
mp4	number or size of nuclei	fewer nuclei / 4 or 1 per cell bigger	more nuclei / 5,6,7 smaller;
mp5	shape of nucleus	oval / irregular or elongated	some round or circular;
mp6	nucleolus	no(ne) or absent or has no or one or not seen / visible	yes or present or has or idea of more or seen or visible;
mp7	packing / layers of cells	less packed / fewer layers few cells	more packed / more layers more cells;
mp8	shape of cells	(cilia end) membrane bulges / curves up thicker or wider	flat or curve down / AW narrower or thinner

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	(ii)		**[4]**
MMO collection 2	[1]	takes at least 3 measurements of the epithelial layer and cilia layer; **I** units	
	[1]	must have mm or cm (for both) once for each **AND** (epithelial) 50 to 80 mm (5 to 8 cm) (cilia) 8 to 18 ... (0.8 to 1.8 cm) or both to 0.5 mm or 0.05 cm	
		Additional guidance **Must be** raw data not mean	
PDO display 2	[1]	show addition / sum of measurements for both divided by the number of measurements;	
		Additional guidance **A** any number of measurements 2 or more	
	[1]	Shows larger number to smaller number **AND** rounds to appropriate number and ratio expressed correctly;	
		Additional guidance **A** any ratio in whole numbers larger to smaller **A** expression as fraction **R** any units	
			[Total: 20]

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GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2011 question paper for the guidance of teachers

9700 BIOLOGY

9700/35 Paper 3 (Advanced Practical Skills 1), maximum raw mark 40

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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Mark scheme abbreviations:

;	separates marking points
/	alternative answers for the same point
R	reject
A	accept (for answers correctly cued by the question, or by extra guidance)
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants excepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
ACE	Analysis, Conclusions and Evaluation (skills)
MMO	Manipulations, Measurement and Observation (skills)
PDO	Presentation of Data and Observations (skills)

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1 (a) (i)			[1]
MMO decisions 1	[1]	one temperature + 80(.0);	
		Additional guidance **A** any range 80 to 100 e.g. 80 to 85	

	(ii)		[2]
MMO decisions 2	[1]	equal volume or excess of Benedict's solution with respect to volume of sampling solution;	
		Additional guidance **A** not less than 2 cm^3 **A** 15 cm^3 or less **A** total volume 20 (not 21) cm^3 **R** whole number only	
	[1]	both must have units cm^3 or ml(s);	

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	(iii)		**[4]**
PDO recording 2	mp1	table with all cells drawn **AND** heading (top or left) with (reaction) time / min(utes);	
		Additional guidance	**A** no outer boundary **A** test-tube or S and E or sampling (solution) with mins **R** mins in body of table **R** test-tube number or test-tube alone **R** if convert to seconds **Ignore** test-tube / additional columns / rows
	mp2	(heading on any one time column or row including mean) time / seconds (s) (to first colour change);	
		Additional guidance	**Ignore** heading for test-tubes **R** headings for standardised variables e.g. volumes or temperature
MMO collection 2	mp3	records results for at least four sample times ;	
		Additional guidance	**A** 0 minutes **A** times or colours(blue to green to yellow to orange to orange/brown to red) **R** 'no change'
	mp4	records as times in whole seconds (numbers) only 'less than 601' time; (mark first column or row of recorded time taken)	
		Additional guidance	**A** minimum of four recorded times including 'more than 600'

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	(iv)		[1]
ACE interpretation **max 1**	max 1	Cause of error	WITH idea of error
	mp1	(dependent) (change of Benedict's solution) judge or observe or identifying colour	is difficult or varies or not same;
	mp2	timing as all test-tubes together or observing change in test-tube	is difficult or varies or not same;
	mp3	(standardised) glucose or sample solution from previous tube or contamination	is transferred on outside of Visking tubing bag to next test-tube;

	(v)	[1]
ACE improvement 1	[1]	boil enzyme (and sucrose) **Or** replace enzyme / **E** with water or use water / **W** instead of enzyme / **E** **Or** replace sucrose with water / **W** or use water instead of sucrose **Or** use sucrose and <u>water / **W**</u> **Or** use enzyme and <u>water / **W**</u>; (Ignore equal volume or 2 cm^3 of each) **Ignore** denature enzyme (needs how) **R** 0% sucrose or 0% enzyme

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(vi)			**[max 2]**
Mark first **three** ideas for any correct **two [max 2]**			
ACE improvements **max 2**	mp1	(independent variable) sample more often (e.g. every 2 minutes) or narrower (range);	
		Additional guidance **R** idea of wider range	
	mp2	(dependent variable) weigh mass of precipitate;	
		Additional guidance **R** colorimeter	
	mp3	(Benedict's) thermostatically-controlled water-bath or water-bath at a named temperature (80 to 100 / boiling);	
		Additional guidance **A** digital or electronic **A** description of use of heating and cooling with Bunsen or hot and cold water	
	mp4	(Benedict's) idea of heat or do each test-tube separately	
	mp5	replicate / repeat;	
		Additional guidance **A** more times/trials/readings or repeats or repeat **Ignore** mean	
	mp6	(standardised variables) use separate Visking tubing bags / one Visking tubing bag for 5 minutes, one for 10 minutes, one for 15 minutes, one for 20 minutes or test the water before putting in Visking tubing;	
	mp7	use a buffer;	
	mp8	check temperature of solution has reached temperature of water-bath or equilibrate enzyme or allow longer time for solutions to reach surrounding temperature in boiling tube;	

(b) (i)			**[1]**
ACE interpretation 1	[1]	missing value 7.82 or 7.8 or 8.0;	
		Additional guidance **R** 8	

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	(ii)		**[4]**
PDO layout 4	O	*x*-axis sucrose conc(entration) mol dm^{-3} **AND** *y*-axis change in mass/g or percentage (%) change in mass; **A** label anywhere on right side of grid	
		Additional guidance **Must have** units on x-axis **AND** y-axis **R** put both units g and % **R** mol/dm^{-3} **A** mol/dm^{3}	
	S	scale as *x*-axis 0.2 to 2 cm **AND** *y*-axis 10 to 2 cm ;	
		Additional guidance **A** no 0 label at origin and no end labels **R** awkward scale	
	P	correct plotting of each point to within half a square i.e. less than 1 mm from intersection i.e. plot has to be nearer than halfway from a line – up or down or either side OR if meant to be between two lines then must not be on line above or below or either side;	
		Additional guidance **A** small cross or dot in circle or cross in circle **A ecf** if *x*-axis not 0 if scale 20 to 2 cm. **R** awkward *y*-axis scale **R** blobs or dots alone **R** cross too large	
	L	ruled lines point to point or ruled lines of best fit **R** extrapolated **A** extrapolation from line of best fit to vertical or horizontal lines of plotted point only	**AND** quality clear sharp; **R if** • less than 5 plots • line 1 mm or thicker • any feathery line • irregular thickness
		Additional guidance **A ecf** from incorrect P	

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	(iii)		[1]
ACE interpretation 1	[1]	circle around 0.8 plotted point;	

	(iv)			[3]
		R if any incorrect ref. to sucrose solution.		
ACE interpretation 1	[1]	(Cell **A** no change in mass) take value for cell **A**	(Cell **B** losing mass) **AND** any value higher than value for cell **A**	(Cell **C** gaining mass) **AND** any value lower than cell **A**;
		example 0.4	example any value more than 0.4	example any value less than 0.4
		Additional guidance **Must have** mol dm^{-3} once		
PDO display 2	[1]	(Cell **A**) no change in <u>mass</u> or 0% change in <u>mass</u>;		
	[1]	(Cell **B**) losing mass or figures most negative change in mass Or idea of more water out / exosmosis Or less water in / endosmosis	**AND** (Cell **C**) gaining mass or positive quote most positive change in mass Or less water out / exosmosis Or more water in / endosmosis;	
		Additional guidance **Ignore** ref. to size		

	(v)		[2]
ACE conclusion 2	[1]	(cell **A**) no net <u>move</u>(ment) or diffusion or equal move(ment) or diffusion (of water) in and out; **R** 'no osmosis'	
	[1]	<u>water potential</u> is same inside and outside cell or no difference;	
			[Total: 22]

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2 (a) (i)		**[6]**
PDO layout 1	[1]	no shading **AND** length across widest point (top to bottom) is more than 50 mm **AND** (clear, sharp, unbroken lines) **Must have four** or more hand-drawn lines and / or enclosed areas (not cells) **R if** • drawn over the print of question • any line 1 mm or thicker • any feathery or broken / dashed • 3 'tails' or overlaps or gaps (ignoring gaps for stomata) • **any** ruled or dashed lines in drawing
MMO collection 3	[1]	no cells drawn **AND** drawn correct part of leaf **AND** one closed end;
	[1]	region across closed end or at least two stomata gaps;
	[1]	(outermost two lines) drawn with two lines closer than 4 mm at widest point **AND** at least three defined enclosed areas (not cells);
MMO decision 2	[1]	at least two of defined enclosed areas divided into two regions OR has three outside layers (four lines) (not including any line for palisade);
	[1]	correct label with one label line to each of palisade mesophyll layer and epidermis; label line to within a defined layer for the palisade mesophyll layer and label line to epidermis between any two lines outside this palisade layer or the outermost line.
		Additional guidance **R if** • any label which is biologically incorrect e.g. from incorrect organ or animal or cell structures • any label within drawn area • any label to open space, epidermis must have two lines

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(ii)		**[6]**
	Ignore any inclusion inside canal.	
PDO layout 1	[1]	no shading **AND** largest dimension of one cell larger than 30 mm in any direction **AND** (clear, sharp, unbroken lines for outer cell lines only) **Must have** five or more enclosed areas **R if** • drawn over the print of question • any line 1 mm or thicker or ruled • any feathery or broken/dashed line • any 'tails' or overlaps or gaps if two lines for cell walls • **any** ruled lines;
MMO collection 3	[1]	only (any) 6 cells touching AND form a single chain in an arc (semicircle or full circle);
		Additional guidance **R** any ruled lines
	[1]	(for innermost cells) cells not uniform size **AND** no extra line (canal lining as a line);
		Additional guidance **R** any ruled lines
	[1]	any one cell showing an inclusion; **R** any three cells with small inclusions / chloroplasts
PDO recording 1	[1]	cell walls as double lines with middle lamella between three adjacent cells;
MMO decision 1	[1]	<u>one</u> correct label (**F**) (with label line) to any <u>one</u> cell with enclosed area drawn inside;
		Additional guidance **R F** not totally inside when no label line **R** label line within cell **R** any label other than **F**

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	(iii)			[max 1]
ACE conclusion **max 1**	**max 1**	(thick) presence of cuticle / lignified / resin cells few air spaces / less spongy mesophyll few stomata or pores	prevents / reduces 'loss of water' or transpiration or evaporation or 'diffusion of water' or trap water;	
		sunken stomata	prevents / reduces diffusion or absorb or trap water or moisture or moist air increase humidity;	

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(b) (i) **[5]**

PDO recording 1 [1]

organise as a table / Venn diagram / ruled boxes **AND** headed L1 and Fig. 2.2 **AND** first difference opposite each other;

MMO decision 1 [1]

only **three** observable differences recorded;

ACE interpretation **max 3** **max 3**

mp	feature	L1	Fig. 2.2
1.	vascular bundle arrangement	in line / along centre / scattered	scattered / within columns random;
2.	vascular bundle number or closeness	few(er) or more or close	more or few(er) or further apart;
3.	air spaces / number of air spaces packing / number of cells	none many / more compact more cells / mesophyll	present few/less loose fewer cell / less mesophyll;
4.	canals or openings	present	none / absent;
5.	number of stomata / guard cells	many / more or few / less	few / less or many / more;
6.	distribution of stomata / guard cells	all round or both sides or upper and / or lower	one side or only upper epidermis or not lower epidermis;
7.	cuticle	present / thick / large	absent / thin / small;
8.	epidermal layers **R** cells	more than one layer / thick large	one layer / thin small;
9.	collenchymas / sclerenchyma	present	absent;
10.	palisade layer or cells	present	absent / not clear;
11.	overall shape	smooth	wavy / irregular;

[Total: 18]

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GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2011 question paper for the guidance of teachers

9700 BIOLOGY

9700/36 Paper 3 (Advanced Practical Skills 2), maximum raw mark 40

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underline	actual word given must be used by candidate (grammatical variants excepted)
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I	ignore
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MMO	Manipulations, Measurement and Observation (skills)
PDO	Presentation of Data and Observations (skills)

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1 (a) (i)		[3]
MMO decisions 1	[1] mp1	(labels under correct sequence of beakers) 2.5 AND 1.2(5) AND 0.6(25);
		Additional guidance **Must have** • % once • concentrations to at least 1 decimal place
MMO decisions 2	[1] mp2	**EITHER** (uses serial dilution) (adds previous concentration of S to **each** of three beakers and same volume) 10 cm^3 of 5(%) or shown by arrow with 10 cm^3 **AND** 10 cm^3 transferred from third beaker to fourth and from fourth beaker to fifth beaker;
		Additional guidance **Must have** cm^3 once **ecf** if mp1 is incorrect
	[1] mp3	(adds (distilled) water / **W** to **each** of three beakers BUT **MUST** add previous concentration to fourth and fifth beakers) water / **W** and 10 cm^3;
		Additional guidance **Must have** cm^3 once **ecf** if mp1 is incorrect and/or if mp2 is incorrect

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OR

max 1

for mp2 and mp3

(uses simple dilution)					
<u>10</u>% (**S**)	2.5 and	**AND**	1.25 and	**AND**	0.625 and 9.375
W	7.5		8.75		
OR					
<u>10</u> % (**S**)	5 and	**AND**	2.5 and	**AND**	1.25 and
W	15		17.5		18.75

Additional guidance

Must have
- cm^3 once
- <u>10</u>(%) for each test-tube with % once or arrow from first beaker to each one

ecf if mp1 is incorrect
R rounded volumes up or down.
R just **S**.

(ii) **[1]**

ACE improvement 1

[1]

boil enzyme (and sucrose)
Or replace enzyme / **E** with water or use water / **W** instead of enzyme / **E**
Or replace sucrose with water / **W** or use water instead of sucrose
Or use sucrose and <u>water / **W**</u>
Or use enzyme and <u>water / **W**</u> ;
(Ignore equal volume or 2 cm^3 of each)

Additional guidance

A ref. to use of test-tube **AND** ref. to idea of only water e.g. in beaker or 20 cm^3 BOTH correct
R ref. to water only with Benedict's
R <u>only 10%</u> sucrose or sucrose AND enzyme AND Benedict's in any combination
R give more than one
Ignore denature enzyme (needs how)

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	(iii)	**[4]**
PDO recording 2	[1]	table with all cells drawn **AND** heading percent(age)conc(entration);
		Additional guidance **A** no outer boundary **A** % or percent(age) **A** test-tube / additional columns or rows or **U** separate **R** units in cells of this column or row **R** other units e.g. mol dm^{-3}
	[1]	(heading for any column or row including mean) time (/) s or sec(ond)s;
		Additional guidance **A** columns / rows for test-tubes or observations **A** notes outside the area of table **R** units in cells of this column or row **R** min(utes) **R** additional method **R** t or T
MMO collection 2	[1]	records whole seconds (numbers) 'less than 601' for ANY 5 concentrations **and U and W** / control (7) anywhere; (mark first column or row of recorded time taken)
		Additional guidance **Must have** • whole numbers • values 600 or less • organised into concentration order or time order ignore **U** and control **Ignore** mean times or .0 results
	[1]	records correct pattern highest concentration recorded is shorter time than next concentration ; (mark first column or row of recorded time taken)
		Additional guidance **A** any values e.g. seconds with tenths or min:sec **A** minimum two recorded times including 'more than 600' once

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	(iv)		**[1]**
ACE interpretation 1	[1]	correct two concentrations from their results as times; (should be 3% so between 5 and 2.5)	
		Additional guidance	**Must be** • between two neighbouring concentrations • if same as one concentration then between lower or higher concentration and value given **R** calculate any value between concentrations

	(v)		**[max 2]**
ACE interpretation **max 2**	**max 2** mp1	(independent variable) Idea of use concentration(s) (more / repeat with more / narrower(ignore wider) **AND** have answer for **(a)(iv)** then either (using estimate) between ... and ... or between 10 and 0.625 / lower / higher in correct context); **ecf** from own results above / below if no answer to **(a)(iv)** **A** only between 10 and 0.625	
	mp2	examples given relevant to their estimate or smaller intervals or repeat **U**;	
		Additional guidance	Give mp1 and mp2 if list at least two more concentrations between correct values or examples of smaller intervals or implies all differences e.g. 0.5% **ecf** from own estimates for above or below range
	mp3	(dependent variable) heat each test-tube separately; **Ignore** ref. to colorimeter	
	mp4	(tests / readings for each concentration) replicate;	
		Additional guidance	**A** more times or repeats or repeat or *repeat **U*** **Ignore** 'take more readings'
	mp5	(standardised variables) use thermostatically-controlled water-bath for Benedict's test or at named temperature for test;	
		Additional guidance	**A** digital or electronic **A** description of use of heating and cooling with Bunsen or hot and cold water

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(b) (i)		[4]
PDO layout 4	O	*x*-axis labelled as storage (/) days **AND** *y*-axis labelled as percentage of <u>vitamin</u> (C content);
		Additional guidance **Must have** units on *x*-axis and *y*-axis **A** %
	S	scale as *x*-axis <u>10 to 2 cm</u> **AND** *y*-axis <u>20 to 2 cm</u> ;
		Additional guidance **A** no 0 label at origin and no end label **R** awkward scale
	P	correct plotting of each point (except 100) to <u>within</u> half a square i.e. less than1 mm from intersection; i.e. plot has to be nearer than halfway from a line – up or down or sideways OR if meant to be between two lines then must not be on line
		Additional guidance **A** small cross or dot in circle or cross in circle **ecf** if *x*-axis not 0 if scale 20 to 2 cm. **R** awkward *y*-axis scale **R** extra plot for reading off (26) using the same symbol as graph plots **R** blobs or dots alone **R** cross too large
	L	<u>(both lines on one set of axes) ruled</u> lines point to point or <u>ruled</u> line of best fit (two plots on line and then one either side of line) **AND** quality clear sharp; **R** extrapolated when point to point **A** extrapolation from line of best fit to vertical or horizontal lines of plotted point only **Must have** key or line labelled with temp.; **R if** • less than 5 plots • line 1 mm or thicker • any feathery line • irregular thickness • line meets top more then 2 mm from 100
		Additional guidance **A ecf** from incorrect P

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	(ii)			**[2]**
ACE conclusion 2	[1]	Idea of comparison between –12 and –6		
		–12 / lower temp	lose less vit C higher vit C at –12	
		OR –6 / higher temp	lose more vit C or decreases more steeply or more significant decrease lower at –6	
		OR as temp. increases / rises	less vit C;	
	[1]	no / partially / can't predict	results provide no evidence / only results for –12 and –6 / no results for 10 / still 13%/some vit C at –6;	
		yes	quote of data –12 (° C) (at 60 days) 86% **AND** –6 (° C) 13%;	
			OR difference 73%	
		Additional guidance	**Must have** percentage / % once	

	(iii)		**[2]**
ACE interpretation 2	[1]	Shows on graph two readings 26 days for –6 and –12; Readings to whole number only	
	[1]	(has used correct readings from graph) to obtain correct answer rounded to whole number; *e.g. 94 – 62 = 32*	
			[Total: 19]

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2 (a) (i)		[6]
	Ignore trichomes and **ignore** cells for mp1 only.	
PDO layout 1	[1]	no shading **AND** larger than 60 mm across widest point **AND** (clear, sharp, unbroken lines) ; **Must have** four or more hand drawn lines and/or enclosed areas (not cells) **R** if drawn over the print of question **R** any line 1 mm or thicker **R** any feathery or three gaps or overlaps in line **R any** ruled or dashed lines in drawing
MMO collection 2	[1]	no cells drawn **AND** only half stem **AND** two corners;
	[1]	bulge on at least one corner **OR** definite region epidermis to epidermis of collenchyma across corner;
	[1]	(epidermis) drawn with two lines closer than 4 mm at widest point **AND** at least one continuous line to show boundary of pith drawn;
MMO decision 2	[1]	*(one vascular bundle drawn in both corners)* at least three regions **AND** vascular bundle drawn within each corner;
		Additional guidance **Must have** both outer and inner lines curved towards the epidermis
	[1]	correct label, with label line to <u>enclosed</u> area, xylem; (should be inner area within vascular bundle)
		Additional guidance **R if** • any label which is biologically incorrect e.g. from incorrect organ or animal • any label within drawn area • any label to open space

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	(ii)	**[6]**
PDO layout 1	[1]	no shading **AND** trichome larger than 30 mm at longest point **AND** (clear, sharp, unbroken lines for outer cell line only); **Must have** five or more enclosed areas **R if** • drawn over the print of question • any line 1mm or thicker • any feathery or broken/dashed line • 0 'tails' or overlaps or gaps • **any** ruled lines
MMO collection 2	[1]	<u>one</u> whole trichome drawn **AND** attached to at least one epidermal cell;
		Additional guidance **R if** any gap between trichome and attached cell **R any** ruled lines
	[1]	five adjacent epidermal cells made of different shapes in a line;
		Additional guidance **R if** internal structures inside cells e.g. vacuole / nuclei **R any** ruled lines
PDO recording 1	[1]	*(any one trichome)* rounded or pointed end **AND** along **MOST** of one cell or across more than one cell **AND** only one cell in each trichome;
MMO decision 2	[1]	cell walls drawn as double lines with middle lamella between at least three adjacent epidermal cells;
	[1]	correct label with label line to <u>trichome</u> and one epidermal <u>cell</u> ;
		Additional guidance **R if** any label is biologically incorrect e.g. epithelium or from incorrect organ or animal or cell organelles **R** any label within drawn area

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	(iii)		**[1]**
		Ignore surface area unless in incorrect context.	
ACE conclusion 1	[1]	absorb or trap water / moisture / moist / air OR prevent predators eating stem OR protection / protects from (mechanical) damage OR prevents 'loss of water' / transpiration / evaporation / 'diffusion of water' OR increase humidity;	

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(b) (i) **[3]**

MMO collection 1 — [1]

measures scale bar correctly in mm;
11.5 or 12(.0) or 12.5 or 13(.0) or 13.5 or 14(.0);

Additional guidance **Can have** 1.15 or 1.2 or 1.25 or 1.3 or 1.35 or 1.4 cm
Must have units somewhere that is clear

EITHER

PDO display 2 — [1]

shows conversion of scale bar measurement to μm
(measurement mm) × 1000
OR
(measurement cm) × 10 000

OR shows conversion of μm to mm or cm
700 ÷1000
OR
700 ÷10 000

Additional guidance **Can have** alternative signs for multiplication and division

PDO display 2 — [1]

shows

measurement of scale bar ÷ scale	Allow range in mm/cm/μm 11.5, 12, 12.5, 13, 13.5, 14		
	in mm e.g. 13	in cm e.g. 1.3	in μm e.g. 13 000
	0.07	0.7	700

AND rounds to whole number ;

(11.5)	× 16
(12)	× 17
(12.5)	× 18
(13)	× 19
(13.5)	× 19
(14)	× 20

OR

PDO display 2 — [1]

shows length of Fig. 2.2 divided by length of scale bar **AND** multiplied by 700 OR multiplied by length of Fig 2.2;
(700 divided by length of scale bar)
Can have between 80 mm / 80.5 to 90 mm ÷ 11.5 to 14 (to 0.5 mm only)
OR 8.0 / 8.05 cm to 9 cm ÷ 1.15 to 1.4 (to 0.05 cm only)

PDO display 2 — [1]

same length of Fig 2.2 in μm divided by answer **AND** rounded to whole number;
A × 16 to × 20 in correct context of length of scale bar

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	(ii)		**[5]**
		Mark first **three** differences only.	
PDO recording 1	[1]	organise as a table / Venn diagram / ruled boxes **AND** headed N1 and (Fig.) 2.2 **AND** first difference opposite each other;	
MMO decision 1	[1]	only **three** observable **differences** recorded ;	

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ACE Interpretation **max 3**

max 3

mp	feature	N1	Fig. 2.2
mp1	*(overall shape or ref. to lumen or pith centre)* ***R** 'not circular' or folded*	lobed or star-shape or has bulges or AW e.g. irregular, square / rectangular, folded	oval or round or circular or AW; **R** regular
mp2	*(corners or collenchymas or sclerenchyma or thickened cells)*	present or yes or has	absent or no(ne) or has not;
mp3	*(vascular bundle position or shape)*	in lobes or bulges or *corners* separate / scattered (at edge) if idea of 'all over' / curved	in a ring or circle or around or surrounding
mp4	*(vascular bundle number)*	few(er) **R** xylem or phloem	lots or more;
mp5	*(vascular bundle sizes vary)*	large <u>and</u> small or vary / different	similar / same size;
mp6	*(<u>trichome(s)</u>)* ***R** smooth / rough*	yes or present or has	no(ne) or absent or has no
mp7	*(centre or pith)* ***R** vacuole*	*not hollow* *(lumen / air space absent or no(ne))*	*hollow* *(lumen air space present or yes or has)*
mp8	*(stomata / pores / openings / lenticels)* *Ignore sunken*	*absent or has not or no(ne) or few*	*present or has or yes or more;*

[Total: 21]

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