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**BIOLOGY**

**9700/51**

Paper 5 Planning, Analysis and Evaluation

**October/November 2017**

MARK SCHEME

Maximum Mark: 30

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**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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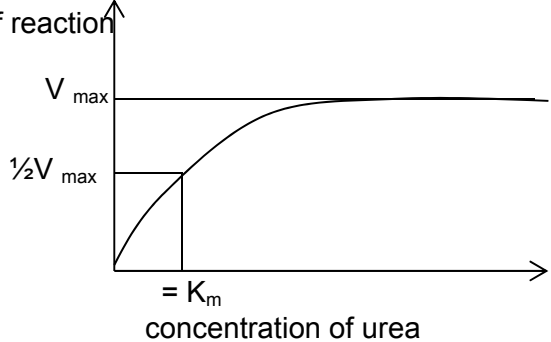
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**Mark scheme abbreviations**

<b>;</b>	separates marking points
<b>/</b>	alternative answers for the same point
<b>R</b>	reject
<b>A</b>	accept (for answers correctly cued by the question, or by extra guidance)
<b>AW</b>	alternative wording (where responses vary more than usual)
<b>underline</b>	actual word given must be used by candidate (grammatical variants accepted)
<b>max</b>	indicates the maximum number of marks that can be given
<b>ora</b>	or reverse argument
<b>mp</b>	marking point (with relevant number)
<b>ecf</b>	error carried forward
<b>I</b>	ignore
<b>AVP</b>	alternative valid point

Question	Answer	Marks
1(a)(i)	weigh / measure (out) / take / put / add / use/ AW, 6 (.01) g urea ; add 500 cm <sup>3</sup> (distilled / deionised) water (and stir until dissolved) ;	<b>2</b>
1(a)(ii)	<i>idea of</i> removing (a known and) same volume of urea solution (with second dilution taken from first dilution, etc.) at each stage of dilution ; <i>idea of</i> adding (a known and) same volume of (distilled) water at each stage of dilution ; <b>A</b> as a diagram showing sequence of dilution <b>A</b> as a table showing volumes (and concentrations) <b>A</b> proportional dilution for max 1 (ecf) if 4 dilutions correctly gained	<b>2</b>
1(b)(i)	<i>independent</i> temperature ; <i>dependent</i> conductivity (of enzyme and substrate / ions / solution) ; <b>A</b> in conductivity units	<b>2</b>
1(b)(ii)	substituting, the active enzyme / urease, by an unreactive substance (at all temperatures) <b>A</b> e.g. boiled or denatured enzyme / water in place of enzyme / 0.0M enzyme / (solution of) urea without urease <b>or</b> substituting, urea / substrate, with water ; I 'use (distilled) water' unqualified <b>A</b> e.g. water in place of substrate / 0.0M substrate / (solution of) urease without urea	<b>1</b>

Question	Answer	Marks
1(b)(iii)	<p><i>max 5 if mp7 not given</i></p> <p><i>any 6 from:</i></p> <p>1 <i>ref. to a suitable range of at least 5 temperatures ; A any 5 in the range 10–70 °C</i></p> <p>2 <i>ref. to using suitable apparatus (to incubate enzyme and urea solutions at constant temperature(s)) ; e.g. (thermostatically controlled) water baths / incubators / thermostatically or temperature controlled room / (magnetic stirrer) hotplate</i>  <b>A</b> beaker plus hot water as water-bath  <b>I</b> air conditioning</p> <p>3 <i>ref. to using same volume of urease each time ; total volume must not exceed 30 cm<sup>3</sup></i></p> <p>4 <i>ref. to using same volume of (each) urea concentration ; total volume must not exceed 30 cm<sup>3</sup></i></p> <p>5 <i>ref. to using (same volume of) buffer to maintain a constant pH ; A use buffer to control pH</i></p> <p><i>procedure:</i></p> <p>6 <i>ref. to incubating urease <b>and</b> urea concentrations separately ;</i></p> <p>7 <i>ref. to mixing urea and urease solutions (on the magnetic stirrer) <b>and</b> immersing (conductivity) probe ; I 'probe is used' unqualified</i></p> <p>8 <i>ref. to taking reading (from meter) at same time (for each solution / temperature) ; A any stated time from 0 s to 5 min</i>  <b>A</b> take reading immediately / AW  <b>A</b> 'use meter to measure rate of reaction' if time context correct</p> <p>9 <i>ref. to testing each of the concentrations (of urea) at each temperature ;</i></p> <p>10 <i>ref. to a min. of 3 replicates / repeats <b>and</b> a mean / find anomalies ;</i></p>	6

Question	Answer	Marks
1(b)(iii)	11 <i>ref. to suitable hazard and precaution ;</i> <b>A</b> low risk experiment <b>I</b> medium risk experiment <b>R</b> no risk / high risk <b>A</b> urease / enzyme is allergen or irritant <b>and</b> wear gloves / goggles <b>A</b> Ammonia (given off at high temperature) is irritant / mask or gloves	
1(c)(i)	1 one curve drawn correctly ; <i>does not need to go through origin</i> <b>A</b> straight line up then level without curving 2 $V_{\max}$ shown ;    rate of reaction  3 $\frac{1}{2}V_{\max}$ shown ; 4 $K_m$ shown ; <b>A</b> Michaelis-Menten (constant)	<b>4</b>
1(c)(ii)	1 <b>D</b> ; 2 (temperature showing) lowest $K_m$ <b>or</b> shows, greater / greatest / higher / highest, affinity (of the, enzyme / urease) for its substrate / AW ;	<b>2</b>

Question	Answer	Marks
2(a)(i)	<p><i>any 1 from:</i></p> <ol style="list-style-type: none"> <li>1 time of soaking (grain in the salt solutions) / 12 hours soaking for each set / AW ;</li> <li>2 number of grains (soaked in each, salt concentration / set / covered petri dish) ;</li> <li>3 temperature (of germination / incubation) ; <i>20 °C if quoted</i></li> <li>4 time intervals of recording (germination) ; <b>A</b> recorded at 8 hour intervals <b>or</b> recorded over 5 days</li> <li>5 <i>idea of</i> taking a standard appearance of grain when judged to be germinated ; e.g. <i>emergence of radicle</i></li> </ol>	<b>1</b>
2(a)(ii)	<p><i>any 1 from:</i></p> <ol style="list-style-type: none"> <li>1 volume of (salt) solution used, on the filter paper / in the (Petri) dish ; <b>I</b> 'amount' unqualified</li> <li>2 age of grain ;</li> <li>3 (use) undamaged / not infected / not diseased / AW, grain ; <b>I</b> size / mass, of grain</li> <li>4 <i>idea of</i> light (exposure of grains during germination / breaking dormancy) ;</li> <li>5 supply of, air / oxygen (to the grain) ;</li> <li>6 <i>idea of</i> spacing of grains ;</li> <li>7 pH (of solution) ;</li> </ol>	<b>1</b>

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2(b)(i)	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th data-bbox="692 220 985 432" rowspan="3" style="text-align: center;">concentration of salt solution / mmoldm<sup>-3</sup></th> <th colspan="4" data-bbox="985 220 1583 331" style="text-align: center;">mean (cumulative) percentage of grains that had germinated each day</th> </tr> <tr> <th colspan="2" data-bbox="985 331 1131 384" style="text-align: center;">1</th> <th colspan="2" data-bbox="1131 331 1583 384" style="text-align: center;">5</th> </tr> <tr> <th data-bbox="985 384 1131 432" style="text-align: center;">X</th> <th data-bbox="1131 384 1274 432" style="text-align: center;">Y</th> <th data-bbox="1274 384 1420 432" style="text-align: center;">X</th> <th data-bbox="1420 384 1583 432" style="text-align: center;">Y</th> </tr> </thead> <tbody> <tr> <td data-bbox="692 432 985 485" style="text-align: center;">0</td> <td data-bbox="985 432 1131 485" style="text-align: center;">93.8</td> <td data-bbox="1131 432 1274 485" style="text-align: center;">92.0</td> <td data-bbox="1274 432 1420 485" style="text-align: center;">98.0</td> <td data-bbox="1420 432 1583 485" style="text-align: center;">97.0</td> </tr> <tr> <td data-bbox="692 485 985 537" style="text-align: center;">10</td> <td data-bbox="985 485 1131 537" style="text-align: center;">93.0</td> <td data-bbox="1131 485 1274 537" style="text-align: center;">90.2</td> <td data-bbox="1274 485 1420 537" style="text-align: center;">97.4</td> <td data-bbox="1420 485 1583 537" style="text-align: center;">96.4</td> </tr> <tr> <td data-bbox="692 537 985 590" style="text-align: center;">20</td> <td data-bbox="985 537 1131 590" style="text-align: center;">92.2</td> <td data-bbox="1131 537 1274 590" style="text-align: center;"><b>87.0 ;</b></td> <td data-bbox="1274 537 1420 590" style="text-align: center;">96.6</td> <td data-bbox="1420 537 1583 590" style="text-align: center;">93.6</td> </tr> <tr> <td data-bbox="692 590 985 643" style="text-align: center;">30</td> <td data-bbox="985 590 1131 643" style="text-align: center;"><b>96.4 ;</b></td> <td data-bbox="1131 590 1274 643" style="text-align: center;">90.0</td> <td data-bbox="1274 590 1420 643" style="text-align: center;">96.4</td> <td data-bbox="1420 590 1583 643" style="text-align: center;">93.0</td> </tr> <tr> <td data-bbox="692 643 985 695" style="text-align: center;">40</td> <td data-bbox="985 643 1131 695" style="text-align: center;">92.0</td> <td data-bbox="1131 643 1274 695" style="text-align: center;">90.4</td> <td data-bbox="1274 643 1420 695" style="text-align: center;">95.4</td> <td data-bbox="1420 643 1583 695" style="text-align: center;">92.4</td> </tr> <tr> <td data-bbox="692 695 985 748" style="text-align: center;">50</td> <td data-bbox="985 695 1131 748" style="text-align: center;">91.3</td> <td data-bbox="1131 695 1274 748" style="text-align: center;">91.0</td> <td data-bbox="1274 695 1420 748" style="text-align: center;">95.0</td> <td data-bbox="1420 695 1583 748" style="text-align: center;">91.6</td> </tr> <tr> <td data-bbox="692 748 985 801" style="text-align: center;">60</td> <td data-bbox="985 748 1131 801" style="text-align: center;">91.2</td> <td data-bbox="1131 748 1274 801" style="text-align: center;">90.0</td> <td data-bbox="1274 748 1420 801" style="text-align: center;">95.0</td> <td data-bbox="1420 748 1583 801" style="text-align: center;">91.0</td> </tr> </tbody> </table>				concentration of salt solution / mmoldm <sup>-3</sup>	mean (cumulative) percentage of grains that had germinated each day				1		5		X	Y	X	Y	0	93.8	92.0	98.0	97.0	10	93.0	90.2	97.4	96.4	20	92.2	<b>87.0 ;</b>	96.6	93.6	30	<b>96.4 ;</b>	90.0	96.4	93.0	40	92.0	90.4	95.4	92.4	50	91.3	91.0	95.0	91.6	60	91.2	90.0	95.0	91.0	<b>2</b>
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2(b)(ii)	<p>1 Pearson's linear correlation ;  <b>A</b> Pearson's      <b>R</b> Pearson's Rank correlation</p> <p>2 data collected is continuous</p> <p><b>or</b> data, is / seems to be, (from a population that is) normally distributed</p> <p><b>or</b> data / results, appears to be linear ;</p>				<b>2</b>																																																

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2(c)	<p><i>I data quotes unqualified</i></p> <p>any 3 from:</p> <ol style="list-style-type: none"> <li>1 <i>idea that</i> (germination is rapid because) nearly all / approx. 90% / majority / most, of grains, germinated during the first day ;</li> <li>2 <i>idea that</i> (control shows) some of the barley, will not germinate, over the period of the experiment / in the first five days ;</li> <li>3 percentage germination (generally), decreases as concentration of salt increases / increases as concentration of salt decreases ; A <i>idea of <u>negative</u></i> correlation</li> <li>4 more grains have germinated after 5 days (than after 1 day) / ora ;</li> </ol>	<b>3</b>
2(d)(i)	<p><i>must be comparative</i> <i>I data quotes unqualified</i></p> <p>germination of barley is, higher / highest, in <b>X</b> (than <b>Y</b> at, all salt concentrations / every value / stated value(s) from 30 mmol dm<sup>-3</sup> to 60 mmol dm<sup>-3</sup>) ;</p>	<b>1</b>
2(d)(ii)	<p>any 1 from:</p> <ol style="list-style-type: none"> <li>1 <i>idea of</i> measuring / recording / investigating / AW, germination of, <b>X</b> and <b>Y</b> / both, in salty <u>soil</u> ;</li> <li>2 <i>idea of</i> measuring / recording / investigating / AW, growth of, <b>X</b> and <b>Y</b> / both, in salty <u>soil</u> ;</li> <li>3 <i>idea of</i> measuring / recording / investigating / AW, yield of, <b>X</b> and <b>Y</b> / both, in salty <u>soil</u> ;</li> <li>4 AVP ; e.g. a field investigation involving a transect across an area from low to high salt then measuring abundance of the types along the transect</li> </ol>	<b>1</b>