

**Mathematics (MEI)**

Advanced GCE 4767

Statistics 2

**Mark Scheme for June 2010**

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**Question 1**

<p><b>(i)</b></p>	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr><td><math>x</math></td><td>6</td><td>17</td><td>9</td><td>20</td><td>13</td><td>15</td><td>11</td><td>14</td></tr> <tr><td><math>y</math></td><td>6</td><td>13</td><td>10</td><td>11</td><td>9</td><td>7</td><td>12</td><td>15</td></tr> <tr><td>Rank <math>x</math></td><td>8</td><td>2</td><td>7</td><td>1</td><td>5</td><td>3</td><td>6</td><td>4</td></tr> <tr><td>Rank <math>y</math></td><td>8</td><td>2</td><td>5</td><td>4</td><td>6</td><td>7</td><td>3</td><td>1</td></tr> <tr><td><math>d</math></td><td>0</td><td>0</td><td>2</td><td>-3</td><td>-1</td><td>-4</td><td>3</td><td>3</td></tr> <tr><td><math>d^2</math></td><td>0</td><td>0</td><td>4</td><td>9</td><td>1</td><td>16</td><td>9</td><td>9</td></tr> </table> <p><math>\Sigma d^2 = 48</math></p> $r_s = 1 - \frac{6\Sigma d^2}{n(n^2 - 1)} = 1 - \frac{6 \times 48}{8 \times 63}$ <p style="text-align: center;">= 0.429 (to 3 s.f.) [allow 0.43 to 2 s.f.]</p>	$x$	6	17	9	20	13	15	11	14	$y$	6	13	10	11	9	7	12	15	Rank $x$	8	2	7	1	5	3	6	4	Rank $y$	8	2	5	4	6	7	3	1	$d$	0	0	2	-3	-1	-4	3	3	$d^2$	0	0	4	9	1	16	9	9	<p>M1 for attempt at ranking (allow all ranks reversed)</p> <p>M1 for <math>d^2</math></p> <p>A1 CAO for <math>\Sigma d^2</math></p> <p>M1 for method for <math>r_s</math></p> <p>A1 f.t. for <math> r_s  &lt; 1</math> NB No ranking scores zero</p>	<p><b>5</b></p>
$x$	6	17	9	20	13	15	11	14																																																	
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<p><b>(ii)</b></p>	<p><math>H_0</math>: no association between <math>X</math> and <math>Y</math> in the population  <math>H_1</math>: some positive association between <math>X</math> and <math>Y</math> in the population</p> <p>One tail test critical value at 5% level is 0.6429          Since <math>0.429 &lt; 0.6429</math>, there is insufficient evidence to reject <math>H_0</math>,</p> <p>i.e. conclude that there is not enough evidence to show positive association between the two judges' scores.</p>	<p>B1 for <math>H_0</math>          B1 for <math>H_1</math>          B1 for population SOI          NB <math>H_0 H_1</math> <u>not</u> <math>\rho</math>          B1 for <math>\pm 0.6429</math>          M1 for sensible comparison with c.v., provided that <math> r_s  &lt; 1</math>          A1 for conclusion in context f.t. their <math>r_s</math> and sensible cv</p>	<p><b>3</b></p> <p><b>3</b></p>																																																						
<p><b>(iii)</b></p>	<p>A bivariate Normal distribution is required.</p> <p>Scatter diagram.</p> <p>Suitable discussion</p>	<p>B1</p> <p>G1 labelled axes          G1 correct points          E1          E1</p>	<p><b>5</b></p>																																																						
<b>TOTAL</b>			<b>16</b>																																																						

## Question 2

(i)	Counts have a uniform average rate of occurrence All counts are independent	E1 E1	<b>2</b>
(ii)	Variance = 3.4	B1	<b>1</b>
(iii)	(A) <i>Either</i> $P(X=3) = 0.5584 - 0.3397 = 0.2187$ <i>Or</i> $P(X=3) = e^{-3.4} \frac{3.4^3}{3!} = 0.2186$ (B) Using tables: $P(X \geq 3) = 1 - P(X \leq 2)$ $= 1 - 0.3397$  $= 0.6603$	M1 for use of tables or calculation A1 M1 for $1 - P(X \leq 2)$ M1 correct use of Poisson tables A1	<b>2</b>  <b>3</b>
(iv)	$\lambda = 12 \times 3.4 = 40.8$  $P(X=40) = e^{-40.8} \frac{40.8^{40}}{40!} = 0.0625$	B1 for mean M1 for calculation A1	<b>3</b>
(v)	Mean no. per hour = $12 \times 3.4 = 40.8$ Using Normal approx. to the Poisson, $X \sim N(40.8, 40.8)$  $P(X \geq 40) = P\left(Z > \frac{39.5 - 40.8}{\sqrt{40.8}}\right)$ $= P(Z > -0.2035) = \Phi(0.2035)$ $= 0.5806$	B1 for Normal approx. B1 for correct parameters (SOI)  B1 for correct continuity corr.  M1 for probability using correct tail A1 CAO (3 s.f.)	<b>5</b>
(vi)	Overall mean = 4.8 $P(X \geq 8) = 1 - P(X \leq 7)$ $= 1 - 0.8867 = 0.1133$	B1 for 4.8  M1 A1	<b>3</b>
		<b>TOTAL</b>	<b>19</b>



**Question 4**

<p>(i)</p>	<p><math>H_0</math>: no association between category of runner and type of running;  <math>H_1</math>: some association between category of runner and type of running;</p> <table border="1" data-bbox="172 465 874 622"> <thead> <tr> <th>EXPECTED</th> <th>Junior</th> <th>Senior</th> <th>Veteran</th> </tr> </thead> <tbody> <tr> <td>Track</td> <td>5.13</td> <td>7.84</td> <td>6.03</td> </tr> <tr> <td>Road</td> <td>6.48</td> <td>9.90</td> <td>7.62</td> </tr> <tr> <td>Both</td> <td>5.40</td> <td>8.25</td> <td>6.35</td> </tr> </tbody> </table> <table border="1" data-bbox="172 694 874 851"> <thead> <tr> <th>CONTRIBUTN</th> <th>Junior</th> <th>Senior</th> <th>Veteran</th> </tr> </thead> <tbody> <tr> <td>Track</td> <td>2.9257</td> <td>0.0032</td> <td>2.6949</td> </tr> <tr> <td>Road</td> <td>0.9468</td> <td>0.3663</td> <td>2.5190</td> </tr> <tr> <td>Both</td> <td>0.3615</td> <td>0.3694</td> <td>0.0192</td> </tr> </tbody> </table> <p><math>\chi^2 = 10.21</math></p> <p>Refer to <math>\chi_4^2</math></p> <p>Critical value at 5% level = 9.488</p> <p>Result is significant</p> <p>There is evidence to suggest that there is some association between category of runner and type of running.                      NB if <math>H_0</math> <math>H_1</math> reversed, or 'correlation' mentioned, do not award first B1 or final E1</p>	EXPECTED	Junior	Senior	Veteran	Track	5.13	7.84	6.03	Road	6.48	9.90	7.62	Both	5.40	8.25	6.35	CONTRIBUTN	Junior	Senior	Veteran	Track	2.9257	0.0032	2.6949	Road	0.9468	0.3663	2.5190	Both	0.3615	0.3694	0.0192	<p>B1</p> <p>M1 A2 for expected values (to 2 dp)                      (allow A1 for at least one row or column correct)</p> <p>M1 for valid attempt at <math>(O-E)^2/E</math>                      A1 for all correct  <small>NB These M1/A1 marks cannot be implied by a correct final value of <math>\chi^2</math></small></p> <p>M1 for summation                      A1 for <math>\chi^2</math></p> <p>B1 for 4 deg of f                      B1 CAO for cv                      B1 FT their 'sensible' <math>\chi^2</math></p> <p>E1 must be consistent with their <math>\chi^2</math></p>	<p><b>1</b></p> <p><b>7</b></p> <p><b>4</b></p>
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<p>(ii)</p>	<ul style="list-style-type: none"> <li>• Juniors appear be track runners more often than expected and road less often than expected.</li> <li>• Seniors tend to be as expected in all three categories of running.</li> <li>• Veterans tend to be road runners more than expected and track runners less than expected.</li> </ul>	<p>E1 E1</p> <p>E1 E1</p> <p>E1 E1</p>	<p><b>6</b></p>																																
<p><b>TOTAL</b></p>			<p><b>18</b></p>																																

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