
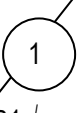


Question Number	Scheme	Marks
1(a) (b) (c)	Treatments are allocated at random within a block where a block is a group of experimental units. 12 $F_{3,12} = 5.95$	B1 B1 (2) B1 (1) B1 B1 (2)
2	$H_0 : \beta = 0.55; H_1 : \beta > 0.55$ both $s^2 = \frac{0.145}{8} = 0.018125$ $t = \frac{0.631 - 0.55}{\sqrt{\frac{0.018125}{2.4137}}} = 0.9347$ CR : $t > 2.896$ Since 0.9347... is not in the critical region there is insufficient evidence to reject H_0 . The regression coefficient is not greater than 0.55	B1 M1 M1 A1 B1 A1√ (6)
3	$H_0 : \text{Median} = 45; H_1 : \text{Median} \neq 45$ Clients – 45 -12, -9, +3, -2, -8, -22, -5, +6, -7, +1 Rank 9 8 3 2 7 10 4 5 6 1 $S+ = 9$ $N = 10, \Rightarrow s = 8$ Since 9 is not in the critical region there is not enough evidence to reject H_0 that the median = 45	B1 B1 M1 M1 A1 B1 M1 A1√ (8)

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4(a)	<p>Between fertilisers S.S. = $\frac{1}{4} \{509^2 + 587^2 + 584^2\} - \frac{1680^2}{12} = 976.5$</p> <p>Residual S.S. = 564.83</p> <table border="1"> <thead> <tr> <th>Source of variation</th> <th>df</th> <th>S.S.</th> <th>M.S.S.</th> <th>F- ratio</th> </tr> </thead> <tbody> <tr> <td>Variety of potato</td> <td>3</td> <td>786.6</td> <td></td> <td></td> </tr> <tr> <td>Fertiliser</td> <td>2</td> <td>976.5</td> <td>488.25</td> <td>5.1864</td> </tr> <tr> <td>Residual</td> <td>6</td> <td>564.83</td> <td>94.138</td> <td></td> </tr> <tr> <td>Total</td> <td>11</td> <td>2328</td> <td></td> <td></td> </tr> </tbody> </table> <p>$F_{2,6} = 5.14$</p> <p>$H_0 : \mu_I = \mu_{II} = \mu_{III}, \quad H_1 : \text{Not all means are equal.} \quad \text{both}$</p> <p>Since 5.1864... is in the Critical region here is evidence that the type of fertiliser affects the yield of potatoes</p>	Source of variation	df	S.S.	M.S.S.	F- ratio	Variety of potato	3	786.6			Fertiliser	2	976.5	488.25	5.1864	Residual	6	564.83	94.138		Total	11	2328			<p>B1</p> <p>B1</p> <p>B1</p> <p>M1 A1</p> <p>M1 A1</p> <p>B1</p> <p>B1</p> <p>A1√</p> <p>(10)</p>
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(b)	<p>Any two of normality, independence, common variance, random allocation.</p>	<p>B1 B1</p> <p>(2)</p>																									
5	<p>$\sum T_1 = 13.5; \quad \sum T_2 = 5.0; \quad \sum T_3 = 5.5; \quad \sum T_4 = 4.5;$</p> <p>$SST = 84.75 - \frac{28.5^2}{11} = 10.9091$</p> <p>$SS \text{ therm} = \frac{13.5^2}{4} + \frac{5.0^2}{2} + \frac{5.5^2}{3} + \frac{4.5^2}{2} - \frac{28.5^2}{11} = 4.4299$</p> <p>Residual S.S. = 6.4792</p> <table border="1"> <thead> <tr> <th>Source of variation</th> <th>df</th> <th>S.S.</th> <th>M.S.S.</th> <th>F- ratio</th> <th>df</th> </tr> </thead> <tbody> <tr> <td>Between thermometers</td> <td>3</td> <td>4.4299</td> <td>1.4762</td> <td>1.595</td> <td>ratio</td> </tr> <tr> <td>Residual</td> <td>7</td> <td>6.4792</td> <td>0.9256</td> <td></td> <td></td> </tr> <tr> <td>Total</td> <td>10</td> <td>10.9091</td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p>$H_0 : \mu_1 = \mu_2 = \mu_3 = \mu_4$ $H_1 : \text{Not all means are equal.}$</p> <p>$Cr : F_7^3 > 4.35$</p> <p>No evidence to reject H_0; No difference between thermometers</p>	Source of variation	df	S.S.	M.S.S.	F- ratio	df	Between thermometers	3	4.4299	1.4762	1.595	ratio	Residual	7	6.4792	0.9256			Total	10	10.9091				<p>B1</p> <p>B1</p> <p>M1 A1</p> <p>B1</p> <p>M1M1A1</p> <p>B1</p> <p>B1</p> <p>A1</p> <p>(12)</p>	
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<p>6. (a)</p>	<p>Time to solve the puzzle is unlikely to be normal, (more likely to be +ve Skew)</p>	<p>B1 (1)</p>																																										
<p>(b)</p>	<p>$H_0 : \text{Median}_A = \text{Median}_B ; H_1: \text{Median}_A \neq \text{Median}_B$</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td>Rank</td> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td></td><td>ranking</td> </tr> <tr> <td>A</td> <td>7</td><td>9</td><td>10</td><td></td><td>12</td><td></td><td>15</td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> <tr> <td>B</td> <td></td><td></td><td></td><td>11</td><td></td><td>14</td><td></td><td>16</td><td>17</td><td>19</td><td>21</td><td></td><td>all correct</td> </tr> </table> <p>Rank sum for TA = 1 + 2 + 3 + 5 + 7 = 18</p> <p>$n_1 = 5; n_2 = 6 \Rightarrow CV = 18$</p> <p>Hence reject H_0 and conclude that the median times to solve the puzzle are not equal.</p> <p>$H_0 : \text{Median}_G = \text{median}_B; H_1 : \text{median}_G \neq \text{Median}_B$ both</p>	Rank	1	2	3	4	5	6	7	8	9	10	11		ranking	A	7	9	10		12		15							B				11		14		16	17	19	21		all correct	<p>B1 M1 A1 M1 A1 B1 B1 (7)</p>
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<p>(c)</p>	<p>Since $n_1 = 25, n_2 = 25$ we use a normal approximation.</p> <p>$T \sim N(637.5, 2656.25)$</p> <p>CR $z < -1.96$ & $z > 1.96$</p> $z = \frac{522 - 637.5 + 0.5}{\sqrt{2656.25}} = -2.313$ <p style="text-align: right;">without 0.5 $z = -2.2410$</p> <p>Since -2.313 is in the critical region H_0 is rejected and it can be concluded that for these boys & girls the median times are not equal.</p>	<p>B1 M1 A1 B1 M1 A1 A1√ (7)</p>																																										

7. (a)	<p>Warning Limits are $12.00 \pm 2.3263 \times \frac{0.35}{\sqrt{10}}$</p> <p>ie 11.7425 & 12.2575</p> <p>Action limits are $12.00 \pm 2.5758 \times \frac{0.35}{\sqrt{10}}$</p> <p>ie 11.7149 & 12.2851</p> <p>Graph</p>	<p>M1</p> <p>2.3263 B1</p> <p>A1</p> <p>B1</p> <p>A1</p> <p></p> <p>(8)</p>
(b)	<p>Graph</p> <p>i) Between warning and action – take another sample</p> <p>ii) Below action limit – take action</p> <p>iii) between warning limits – no action needed</p>	<p></p> <p>B1√</p> <p>B1√</p> <p>B1√</p> <p>(4)</p>
(c)	<p>95% confidence interval for σ^2 is given by</p> <p>$2.7 < \frac{9 \times 0.12}{\sigma^2} < 19.023$</p> <p>ie $0.057 < \sigma^2 < 0.400$</p>	<p>use of $(n-1)s^2/\sigma^2 \sim \chi^2_{n-1}$</p> <p>2.7</p> <p>19.023</p> <p>Correct expression</p> <p>M1</p> <p>B1</p> <p>B1</p> <p>A1</p> <p>A1</p> <p>(5)</p>

