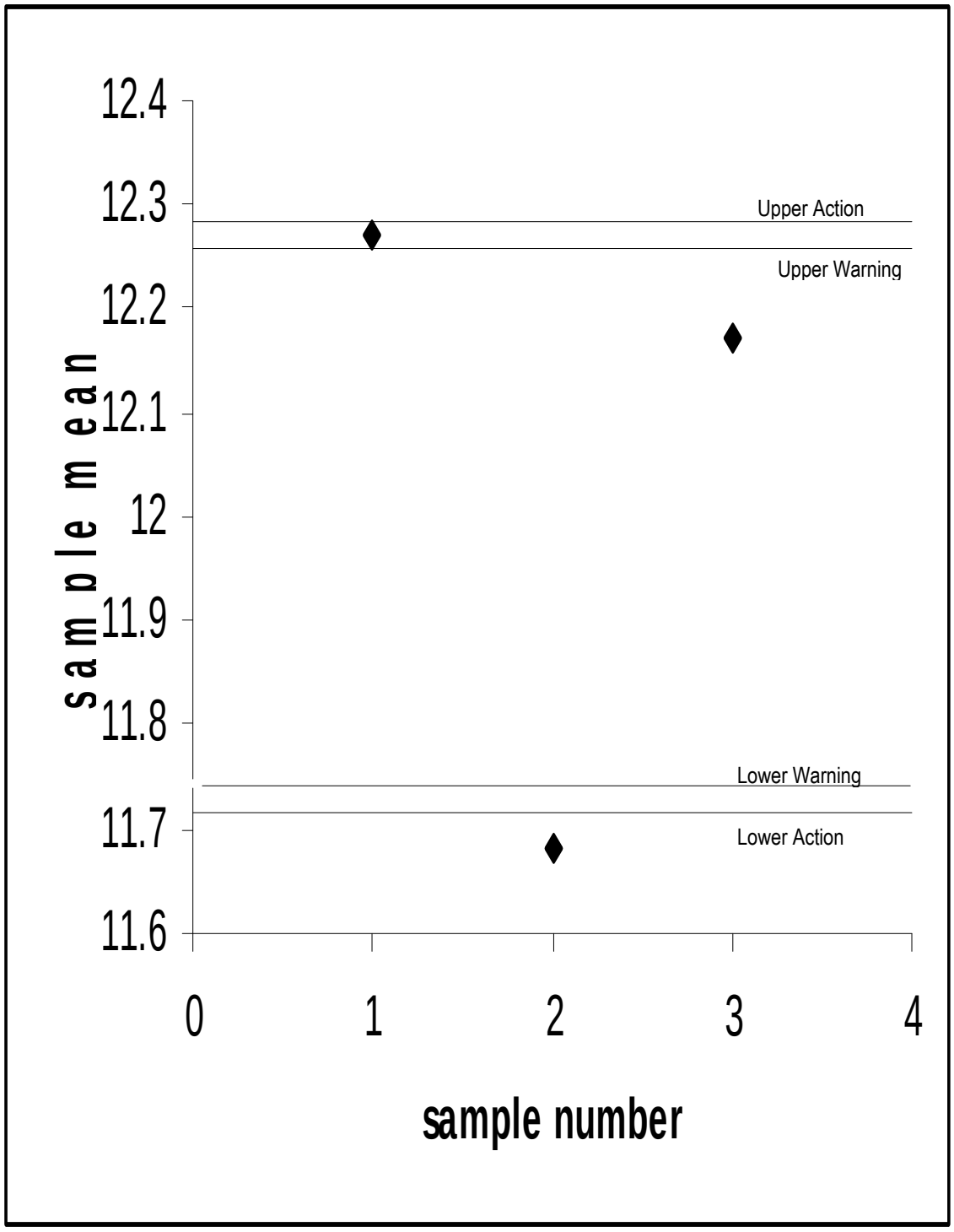
Question Number	Scheme	Marks
1(a)	Treatments are allocated at random within a block where a block is a group of experimental units.	B1 B1
(b)	12	(2)
(c)	$F_{3,12} = 5.95$	B1 (1)
		B1 B1 (2)
2	$H_0 : \beta = 0.55$; $H_1: \beta > 0.55$ both	B1
	$s^2 = \frac{0.145}{8} = 0.018125$	M1
	$t = \frac{0.631 - 0.55}{\sqrt{\frac{0.018125}{2.4137}}} = 0.9347$	M1 A1
	CR : $t > 2.896$	B1
	Since 0.9347… is not in the critical region there is insufficient evidence to reject H0. The regression coefficient is not greater than 0.55	A1√ (6)
3	H_0 : Median = 45; H_1 : Median $\neq$ 45	B1 B1
	Clients – 45 –12, –9, +3, –2, –8, –22, –5, +6, –7, +1 Rank 9 8 3 2 7 10 4 5 6 1	M1 M1
	S+ = 9	A1
	N = 10, $\Rightarrow$ s = 8	B1
	Since 9 is not in the critical region there is not enough evidence to reject H_0 that the median = 45	M1 A1√ (8)

Question Number	Scheme	Marks
4(a)	Between fertilisers S.S. = $\frac{1}{4}\{509^2 + 587^2 + 584^2\} - \frac{1680^2}{12} = 976.5$	B1
	Residual S.S. = $564.8\dot{3}$	B1
	Source of variation / df / S.S. / M.S.S. / F- ratio Variety of potato / 3 / $786.\dot{6}$ Fertiliser / 2 / 976.5 / 488.25 / 5.1864 Residual / 6 / $564.8\dot{3}$ / $94.13\dot{8}$ Total / 11 / 2328	B1 df M1 A1 MSS M1 A1 F
	$F_{2,6} = 5.14$	B1
	$H_0 : \mu_I = \mu_{II} = \mu_{III,}$ H_1 : Not all means are equal. both	B1
	Since 5.1864… is in the Critical region here is evidence that the type of fertiliser affects the yield of potatoes	A1√ (10)
(b)	Any two of normality, independence, common variance, random allocation.	B1 B1 (2)
5	$\sum T_1 = 13.5; \quad \sum T_2 = 5.0; \quad \sum T_3 = 5.5; \quad \sum T_3 = 4.5;$	B1
	SST = $84.75 - \frac{28.5^2}{11} = 10.9091$	B1
	SS therm = $\frac{13.5^2}{4} + \frac{5.0^2}{2} + \frac{5.5^2}{3} + \frac{4.5^2}{2} - \frac{28.5^2}{11} = 4.4299$	M1 A1
	Residual S.S. = 6.4792	B1
	Source of variation / df / S.S. / M.S.S. / F- ratio Between thermometers / 3 / 4.4299 / 1.4762 / 1.595 Residual / 7 / 6.4792 / 0.9256 Total / 10 / 10.9091	B1 df M1M1A1 ratio
	$H_0 : \mu_1 = \mu_2 = \mu_3 = \mu_4$ H_1 : Not all means are equal.	B1
	Cr : $F_7^3 > 4.35$	B1
	No evidence to reject H0; No difference between thermometers	A1 (12)

6. (a)	Time to solve the puzzle is unlikely to be normal, (more likely to be +ve Skew)	B1 (1)
	H_0 : Median $_A$ = Median $_B$; H_1: Median$_A$ $\neq$ Median $_B$	
(b)	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	B1 M1 A1
	Rank sum for TA = 1 + 2 + 3 +5 + 7 = 18	M1 A1
	$n_1 = 5$; $n_2 = 6 \Rightarrow$ CV = 18	B1
	Hence reject H_0 and conclude that the median times to solve the puzzle are not equal.	B1
	H_0 : Median$_G$ = median$_B$; H_1 : median$_G$ $\neq$ Median$_B$ both	(7)
(c)	Since $n_1 = 25$, $n_2 = 25$ we use a normal approximation.	B1
	T~ N(637.5, 2656.25)	
	CR z < - 1.96 & z > 1.96	M1 A1
	z = $\frac{522 - 637.5 + 0.5}{\sqrt{2656.25}} = -2.313$ without 0.5 z = -2.2410	B1 M1 A1
	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.	A1√ (7)

7. (a)	Warning Limits are $12.00 \pm 2.3263 \times \frac{0.35}{\sqrt{10}}$	2.3263	M1 B1
	ie 11.7425 & 12.2575		A1
	Action limits are $12.00 \pm 2.5758 \times \frac{0.35}{\sqrt{10}}$	2.5758	B1 A1
	ie 11.7149 & 12.2851		
	Graph		3 (8)
(b)	Graph		1
	i) Between warning and action – take another sample		B1√
	ii) Below action limit – take action		B1√
	iii) between warning limits – no action needed		B1√ (4)
(c)	95% confidence interval for σ^2 is given by		
		use of $(n-1)s^2/\sigma^2 \sim \chi^2_{n-1}$	M1 B1
	$2.7 < \frac{9 \times 0.12}{\sigma^2} < 19.023$	2.7	B1
		19.023	A1
		Correct expression	A1
	ie $0.057 < \sigma^2 < 0.400$		(5)


12.4
12.3
12.2
12.1
12
11.9
11.8
11.7
11.6
sample mean
Upper Action
Upper Warning
Lower Warning
Lower Action
0
1
2
3
4
sample number