GCE

Edexcel GCE

Mathematics

Statistics 4 (6686)

June 2008

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Mark Scheme (Final)

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Mathematics

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6686 Statistics S4
Mark Scheme

Question Number	Scheme	Marks
1 a	E(θ_1) = $\dfrac{\mathrm{E}(X_3)+\mathrm{E}(X_4)+\mathrm{E}(X_5)}{3}$	
	= $\dfrac{3\mu}{3}$	
	= μ $\text{Bias} = 0$ allow unbiased	B1
	E(θ_2) = $\dfrac{E(X_{10}) - E(X_1)}{3}$	
	= 1/3($\mu - \mu$)	
	= 0 Bias = -μ allow $\pm\mu$	B1,B1
	E(θ_3) = $\dfrac{3\mathrm{E}(X_1)+2\mathrm{E}(X_2)+\mathrm{E}(X_{10})}{6}$	
	= $\dfrac{3\mu+2\mu+\mu}{6}$	
	= μ $\text{Bias} = 0$ allow unbiased	B1
		(4)
b	Var(θ_1) = $\frac{1}{9}$\{(Var X_2) + Var(X_3) + Var(X_4)\}	M1
	= $\frac{1}{9}\{\sigma^2+\sigma^2+\sigma^2\}$	
	= $\frac{1}{3}\sigma^2$	A1
	Var(θ_2) = $\frac{2}{9}\sigma^2$	B1
	Var(θ_3) = $\frac{1}{36}\{9\sigma^2+4\sigma^2+\sigma^2\}$	M1
	= $\frac{7}{18}\sigma^2$	A1
		(5)
ci)	θ_1 is the better estimator. It has a lower var. and no bias	B1 depB1
ii)	θ_2 is the worst estimator. It is biased	B1 depB1
		(4)

Question Number	Scheme	Marks
2 a	$H_1 : \sigma_A{}^2 = \sigma_B{}^2 \quad H_0 : \sigma_A{}^2 \neq \sigma_B{}^2$	B1
	$S_A{}^2 = 22.5 \qquad s_B{}^2 = 21.6$ awrt	M1 A1A1
	$\frac{s_1^2}{s_2^2} = 1.04$	M1 A1
	$F_{(8,\,6)} = 4.15$	B1
	1.04 < 4.15 do not reject H_0. The variances are the same.	B1 (8)
b	Assume the samples are selected at random, (independent)	B1 (1)
c	$s^2{}_p = \frac{8(22.5)+6(21.62)}{14} = 22.12$ awrt 22.1	M1 A1
	$H_0 : \mu_A = \mu_B \qquad H_1 : \mu_A \neq \mu_B$	B1
	$t = \frac{40.667-39.57}{\sqrt{22.12}\sqrt{\frac{1}{9}+\frac{1}{7}}}$	M1
	= 0.462 0.42 – 0.47	A1
	Critical value = $t_{14}(2.5\%) = 2.145$	B1
	0.462 < 2.145 No evidence to reject H_0. The means are the same	B1 (7)
d	Music has no effect on performance	B1 (1)

Question Number	Scheme	Marks
3	Differences 2.1 -0.7 2.6 -1.7 3.3 1.6 1.7 1.2 1.6 2.4 $\bar{d}$ = 1.41	M1 M1
	$H_0 : \mu_d = 0 \quad H_1 : \mu_d > 0$	B1
	$s = \sqrt{\frac{40.65 - 10\times1.41^2}{9}}$ = 1.5191…	M1
	$t = \frac{1.41}{\left(\frac{1.519...}{\sqrt{10}}\right)}$ = 2.935… awrt 2.94 /2.93	M1 A1
	t_9 (1%) = 2.821	B1
	2.935.. > 2.821 Evidence to reject H_0. There has been an increase in the mean weight of the mice.	B1ft
		(8)

2 sample test can score
M0 M0
B1 for $H_0 : \mu_A = \mu_B \quad H_1 : \mu_A < \mu_B$

M1 $\frac{9\times24.5 + 9\times17.16}{18}$
M0 A0
B1 2.552
B1 ft

ie 4/8

Question Number	Scheme	Marks
4a	$\bar{x} = 668.125$ $s = 84.428$	M1 M1
	$T_7(5\%) = 1.895$	B1
	Confidence limits = $668.125 \pm \dfrac{1.895 \times 84.428}{\sqrt{8}}$	M1
	= 611.6 and 724.7	A1A1
	Confidence interval = (612, 725)	
		(6)
b	Normal distribution	B1
		(1)
c	£650 is within the confidence interval. No need to worry.	B1 √ B1 √
		(2)

Question Number	Scheme	Marks
5 a		
	Confidence interval = $\left(\frac{15\times 0.003}{27.488}, \frac{15\times 0.003}{6.262}\right)$	M1 B1B1
	= (0.00164, 0.00719)	A1 A1
		(5)
b	0.07^2 =0.0049	M1
	0.0049 is within the 95% confidence interval.	A1
	There is no evidence to reject the idea that the standard deviation of the volumes is not 0.07 or The machine is working well.	A1
		(3)

Question Number	Scheme Marks	
6 a	H_0 $p = 0.35$ $H_1 : p \neq 0.35$	B1 B1
		(2)
b	Let X = Number cured then $X \sim$ B(20, 0.35)	B1
	α = P(Type I error) = P($x \leq 3$) +P($x \geq 11$) given p= 0.35	M1
	= 0.0444 + 0.0532	
	= 0.0976	A1
		(3)
c	β = P(Type II error) = P($4 \leq x \leq 10$)	M1
	p 0.2 0.3 0.4 0.5	
	β 0.5880 0.8758 0.8565 0.5868	A1A1
		(3)
d	Power = 1 – B	M1
	0.4120 0.1435	A1
		(2)
e	Not a good procedure.	B1
	Better further away from 0.35 or	B1dep
	This is not a very powerful test (power = 1 - β)	(2)

Question Number	Scheme	Marks
7 a	$H_0 : \mu = 230 \quad H_1 : \mu < 230$	B1
	$\nu = 9$	
	From table critical value $= \pm 1.833$	B1√
	$\bar{x} = 228.3 \quad S = 17.858$	B1 B1
	$t = \dfrac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$	M1
	$= \pm \dfrac{228.3 - 230}{\frac{17.858}{\sqrt{10}}} = \pm 0.301$	A1
	$\pm 0.301 > \pm 1.833$. No evidence to reject H_0. Mean is 230 N/mm^2	B1 (7)
b	Since the tensile strength is the same and the price is cheaper recommend use new supplier.	B1 (1)