edexcel

GCE

Edexcel GCE

Mathematics

Statistics 4 S4 (6686)

June 2008

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Mark Scheme

Edexcel GCE

Mathematics

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

June 2008
6686 Statistics Mathematics
Mark Scheme

Question Number	Scheme	Marks
1 a	E(θ_1) = $\frac{E(x_3)+E(x_4)+E(x_5)}{3}$	
	= $\frac{3\mu}{3}$	
	= μ Bias $= 0$ allow unbiased	B1
	E(θ_2) = $\frac{E(x_{10}) - E(x_1)}{3}$	
	= 1/3($\mu - \mu$)	
	= 0 Bias = -μ allow $\pm\mu$	B1,B1
	E(θ_3) = $\frac{3E(x_1)+2E(x_2)+E(x_{10})}{6}$	
	= $\frac{3\mu+2\mu+\mu}{6}$	
	= μ 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) = $\frac{14}{36}\{9\sigma^2 + 4\sigma^2 + \sigma^2\}$	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	$H_1 : \sigma_1^2 = \sigma_2^2 \quad H_0 : \sigma_1^2 \neq \sigma_2^2$	B1
	$s_1^2 = 22.5 \qquad s_2^2 = 21.62$	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	B1
		(1)
c	$s^2p = \frac{8(22.5) + 6(21.62)}{14} = 22.12$	M1 A1
	$H_0 : \mu_1 = \mu_2 \qquad H_1 : \mu_1 \neq \mu_2$	B1
	$t = \frac{40.667 - 39.57}{\sqrt{22.12}\sqrt{\frac{1}{9} + \frac{1}{7}}}$	M1
	$= 0.462$	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 concentration	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	M1
	$\bar{d}$ = 1.41	M1
	$H_0 : \mu_d = 0 \quad H_1 : \mu_\delta > 0$	B1
	$s = \sqrt{\dfrac{40.65 - 10\times 1.41^2}{9}} = 1.5191\ldots$	M1
	$t = \dfrac{1.41}{\left(\dfrac{1.519...}{\sqrt{10}}\right)} = 2.935\ldots$	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.	B1
		(8)

Question Number	Scheme	Marks
4a	$\bar{x} = 668.125$ $s = 84.428$	M1 M1
	$T_7(5\%) = 1.895$	B1
	Confidence limits = $668.125 \pm \frac{1.895 \times 84.428}{\sqrt{8}}$	M1
	= 611.5 and 724.7 Confidence interval = (612, 725)	A1A1
		(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
	= (0.00159, 0.00698)	A1 A1 (5)
b	0.07^2 =0.0049 0.0049 is within the 95% confidence interval. There is no evidence to reject the idea that the standard deviation of the volumes is not 0.07	M1 B1 B1 (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 = 0.0444 + 0.0532 = 0.0976	M1 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 0.4120. 1435	M1 A1 (2)
e	This is not a very powerful test (power = 1 - β) Any two Better further away from 0.35 Not a good procedure.	B1 B1 (2)

Question Number	Scheme	Marks
7 a	$H_0 : \mu = 230 \quad H_1 : \mu < 230$	B1
	$\nu = 9$	
	From table critical value = 1.833	B1√
	$\bar{x} = 228.3 \quad S = 17.858$	B1 B1
	$t = \dfrac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$	M1
	$= \dfrac{228.3 - 230}{\frac{17.858}{\sqrt{10}}} = -0.301$	A1
	0.301 < 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 use new supplier.	B1 (1)