

Mark Scheme (Results) Summer 2010

GCE

GCE Statistics S4 (6686/01)

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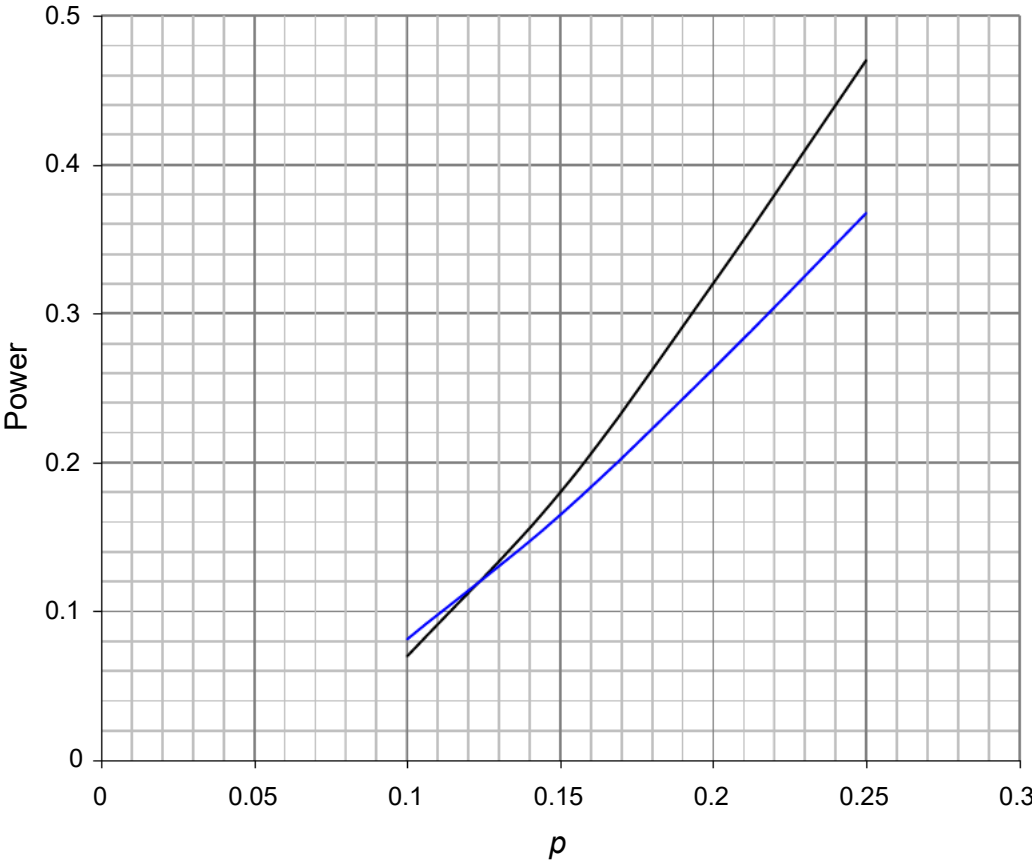
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June 2010
 Statistics S4 6686
 Mark Scheme

Question Number	Scheme	Marks
Q1 (a)	$H_0 : \sigma_1^2 = \sigma_2^2, H_1 : \sigma_1^2 \neq \sigma_2^2$	B1
	critical values $F_{6,7} = 3.87 \left(\frac{1}{F_{6,7}} = 0.258 \right)$	B1
	$\frac{s_2^2}{s_1^2} = \frac{5.2^2}{4.1^2}; = 1.61 \left(\frac{s_1^2}{s_2^2} = \frac{4.1^2}{5.2^2} = 0.622 \right)$	M1; A1
	Since 1.61 (0.622) is not in the critical region we accept H_0 and conclude there is no evidence that the two variances are different	A1ft (5)
(b)	$Sp^2 = \frac{7 \times 4.1^2 + 6 \times 5.2^2}{7 + 6} = 21.53\dots$	M1A1
	$t_{13} = 3.012$	B1
	$99\% \text{ CI} = (17.9 - 15.9) \pm 3.012 \times \sqrt{21.53} \times \sqrt{\frac{1}{8} + \frac{1}{7}}$ $= \pm (9.23, -5.233), [\text{ or accept: } [0, 9.23] \text{ or } [-9.23, 0]]$ awrt 9.23, -5.23	M1A1ft A1A1 (7)
(c)	a person will be quicker at the task second time through/ times not independent/ familiar with the task/groups are not independent	B1 (1)
	Notes B1 Allow $\sigma_1 = \sigma_2$ and $\sigma_1 \neq \sigma_2$ B1 must match their F $\frac{s_2^2}{s_1^2}$ M1 for $\frac{s_2^2}{s_1^2}$ or other way up A1 awrt 1.61(0.622) M1 A1 Sp^2 may be seen in part a B1 3.012 only $M1 \text{ for } (17.9 - 15.9) \pm t \text{ value} \times \sqrt{S_p^2} \times \sqrt{\frac{1}{8} + \frac{1}{7}}$ A1ft their Sp^2 A1 awrt 9.23/-9.23 A1 awrt -5.23/5.23 (c) B1 any correct sensible comment	[13]

Question Number	Scheme	M...
<p>Q2 (a) The differences in the mean heart rates are normally distributed.</p> <p>(b) D = standing up – lying down $H_0: \mu_D = 5$ $H_1: \mu_D > 5$ d: 9, 6, 4, 2, 8, 9, 3, 5, 7, 7</p> $\bar{d} = 6; \quad s_d = \sqrt{\frac{414 - 10 \times 36}{9}} = 2.45$ $t_9 = \frac{6 - 5}{\frac{2.45}{\sqrt{10}}} = 1.29$ $t_9(5\%) = 1.833$ <p>insignificant. There is no evidence to suggest that heart rate rises by more than 5 beats when standing up.</p> <p>Notes must have “The differences in (mean heart rate) are normally distributed) B1 both correct allow $\mu_D - 5 > 0$ ($\mu_D = -5$ $H_1: \mu_D < -5$) M1 finding differences M1 finding \bar{d} M1 $\sqrt{\frac{\sum d^2 - 10 \times (\bar{d})^2}{9}}$ o.e $\pm \left(\frac{6 - 5}{\frac{s_d}{\sqrt{10}}} \right)$ M1 need to see full expression with numbers in A1 awrt ± 1.29 . B1 ± 1.833 only A1 ft their CV and t. Need context. Heart rate and 5 beats</p>	<p>B1</p> <p>B1</p> <p>M1</p> <p>M1;M1</p> <p>M1A1</p> <p>B1</p> <p>A1 ft (8)</p> <p>[9]</p>	

Question Number	Scheme	M...
Q3 (a)	$X \sim B(5, p)$ Size = $P(\text{reject } H_0 / p = 0.05)$ $= P(X > 1 / p = 0.05)$ $= 1 - 0.9774$ $= 0.0226$	M1 A1 (2)
(b)	Power = $1 - P(0) - P(1)$ $= 1 - (1 - p)^5 - 5(1 - p)^4 p$ $= 1 - (1 - p)^4 (1 - p + 5p)$ $= 1 - (1 - p)^4 (1 + 4p)$	M1 M1 A1cso (3)
(c)	$Y \sim B(10, p)$ P (Type I error) = $P(Y > 2 / p = 0.05)$ $= 1 - 0.9885$ $= 0.0115$	M1 A1 (2)
(d)	$s = 0.18$	B1 (1)
(e)		B1ft (1)

Question Number	Scheme	M
(f)	<p>i intersection 0.12 – 0.13 “their graphs intersection”</p> <p>ii if $p > 0.12$ the deputy’s test is more powerful.</p>	<p>B1ft</p> <p>B1 (2)</p>
(g)	<p>More powerful for $p < 0.12$ and p unlikely to be above 0.12</p> <p>Allow it would cost more/take longer/more to sample</p>	<p>B1 (1)</p>
[12]		
Notes		
(a) M1 for finding $P(X > 1)$ A1 awrt 0.0226		
(b) M1 for $1 - P(0) - P(1)$ M1 for $1 - (1 - p)^5 - 5(1 - p)^4 p$ A1 cso		
(a) M1 for finding $P(Y > 2)$ A1 awrt 0.0115		
(b) B1 0.18 cao		
(c) B1 graph. ft their value of s		
(d) B1 ft their intersection. B1 deputy test more powerful o.e.		
(e) If give first statement they must suggest p unlikely to be above 0.12		

Question Number	Scheme	M...
Q4 (a)	$\bar{x} = \frac{291}{15} = 19.4 \quad s = \sqrt{\frac{5968 - 15\bar{x}^2}{14}} = 4.800$ <p>i $t_{14} = 2.145$</p> $95\% \text{ CI} = 19.4 \pm 2.145 \times \frac{4.800}{\sqrt{15}}$ $= (16.7, 22.1)$ <p>ii 95% CI is given by</p> $\frac{14 \times 4.800^2}{26.119} < \sigma^2 < \frac{14 \times 4.800^2}{5.629}$ $(12.4, 57.3) \qquad \text{accept } 12.3$	<p>M1M1</p> <p>B1</p> <p>M1 A1ft</p> <p>A1A1</p> <p>M1 B1B1</p> <p>A1A1 (12)</p>
(b)	<p>Require $P(X > 23) = P\left(Z > \frac{23 - \mu}{\sigma}\right)$ to be as large as possible OR $\frac{23 - \mu}{\sigma}$ to be as small as possible; both imply highest σ and μ. $\frac{23 - 22.1}{\sqrt{57.3..}} = 0.124$</p> $P(Z > 0.124) = 1 - 0.5478$ $= 0.4522$ <p>Notes</p> <p>(a)(i) M1 $\frac{291}{15}$</p> <p>M1 $\sqrt{\frac{5968 - 15\bar{x}^2}{14}}$</p> <p>B1 2.145</p> <p>M1 $(19.4) \pm t \times \frac{\text{"their s"}}{\sqrt{15}}$</p> <p>A1ft $19.4 \pm 2.145 \times \frac{\text{"their s"}}{\sqrt{15}}$</p> <p>A1 awrt 16.7</p> <p>A1 awrt 22.1</p> <p>$\frac{14 \times s^2}{\chi^2}$</p> <p>(ii) M1 χ^2</p> <p>B1 26.119</p> <p>B1 5.629</p> <p>A1 awrt 12.4/12.3</p> <p>A1 awrt 57.3</p> <p>(b) M1 use of highest mean and sigma</p> <p>M1 standardising using values of mean and sigma from intervals</p> <p>M1 finding $1 - P(z > \text{their value})$</p> <p>A1 awrt 0.45</p>	<p>M1M1</p> <p>M1</p> <p>A1 (4)</p> <p>[16]</p>

Question Number	Scheme	M...
<p>Q5 (a)</p> <p>(b)</p>	<p>$H_0: \mu = 70$ [accept ≤ 70], $H_1: \mu > 70$</p> $t = \frac{71.2 - 70}{3.4 / \sqrt{20}} = 1.58$ <p>critical value $t_{19}(5\%) = 1.729$</p> <p>not significant, insufficient evidence to confirm manufacturer's claim</p> <p>$H_0: \sigma^2 = 16$, $H_1: \sigma^2 \neq 16$</p> <p>test statistic $\frac{(n-1)s^2}{\sigma^2} = \frac{219.64}{16} = 13.7..$</p> <p>critical values $\chi_{19}^2(5\%)$ upper tail = 32.852 $\chi_{19}^2(5\%)$ lower tail = 8.907 not significant</p> <p>Insufficient evidence to suggest that the variance of the miles per gallon of the panther is different from that of the Tiger.</p> <p>Notes</p> <p>(a) B1 both hypotheses using μ M1 $\frac{71.2 - 70}{3.4 / \sqrt{20}}$ A1 awrt 1.73 A1 correct conclusion ft their t value and CV</p> <p>(b) B1 both hypotheses and 16. accept $\sigma=4$ and $\sigma \neq 4$ M1 $\frac{(19) \times 3.4^2}{16}$ allow $\frac{(19) \times 3.4^2}{4}$ A1 awrt 13.7 B1 32.852 B1 8.907 A1 correct contextual comment NB those who use $\sigma^2 = 4$ throughout can get B0 M1 A0B1 B1 A1</p>	<p>B1</p> <p>M1A1</p> <p>B1</p> <p>A1 ft (5)</p> <p>B1</p> <p>M1 A1</p> <p>B1</p> <p>B1</p> <p>A1ft (6)</p> <p>[11]</p>

Question Number	Scheme	Mks
Q6 (a)	$X_1 \sim \text{Po}(3\lambda)$ $X_2 \sim \text{Po}(7\lambda)$ $X_3 \sim \text{Po}(10\lambda)$ $E(\hat{\lambda}) = k [E(X_1) + E(X_2) + E(X_3)]$ $= 20\lambda k$ $\hat{\lambda} \text{ unbiased therefore } 20\lambda k = \lambda$ $k = \frac{1}{20}$	<p>M1</p> <p>M1</p> <p>M1</p> <p>A1 (4)</p>
(b)	$\text{Var}(\hat{\lambda}) = \frac{1}{20^2} \text{Var}(X_1 + X_2 + X_3)$ $= \frac{1}{20^2} (3\lambda + 7\lambda + 10\lambda)$ $= \frac{\lambda}{20}$	<p>M1</p> <p>M1</p> <p>A1ft (3)</p>
(c)	$Y \sim \text{Po}(4\lambda)$ $E\left(\frac{1}{4}\bar{Y}\right) = \frac{1}{4} \times 4\lambda = \lambda \text{ therefore unbiased}$	<p>M1 A1 (2)</p>
(d)	$\text{Var}\left(\frac{1}{4}\bar{Y}\right) = \frac{1}{16} \times \frac{4\lambda}{n}$ $= \frac{\lambda}{4n}$	<p>M1 B1</p> <p>A1 (3)</p>
(e)	$\frac{\lambda}{4n} < \frac{\lambda}{20}$ $n > 5 \text{ therefore } n = 6$	<p>M1</p> <p>A1 (2)</p> <p>[14]</p>

Question Number	Scheme	Mks
Q6	<p>Notes</p> <p>(a) M1 all 3 needed. Poisson and mean M1 adding their means M1 putting their $E(\hat{\lambda}) = \lambda$ A1 cao</p> <p>(b) M1 use of $k^2 \text{Var}(X_1 + X_2 + X_3)$ M1 using their means from part(a) as Variances and adding together A1 cao</p> <p>(c) M1 use of 4λ A1 cso plus conclusion. Accept working out bias to = 0</p> <p>(d) M1 $\frac{1}{16} \times \text{Var}\bar{Y}$ B1 for $\text{Var}\bar{Y} = \frac{4\lambda}{n}$ A1 cao</p> <p>(e) M1 for $\text{Var}\left(\frac{1}{4}\bar{Y}\right) < \text{Var}(\hat{\lambda})$ A1 n = 6</p>	

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