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Mark Scheme (Results)
Summer 2010

GCE

GCE Statistics S4 (6686/01)

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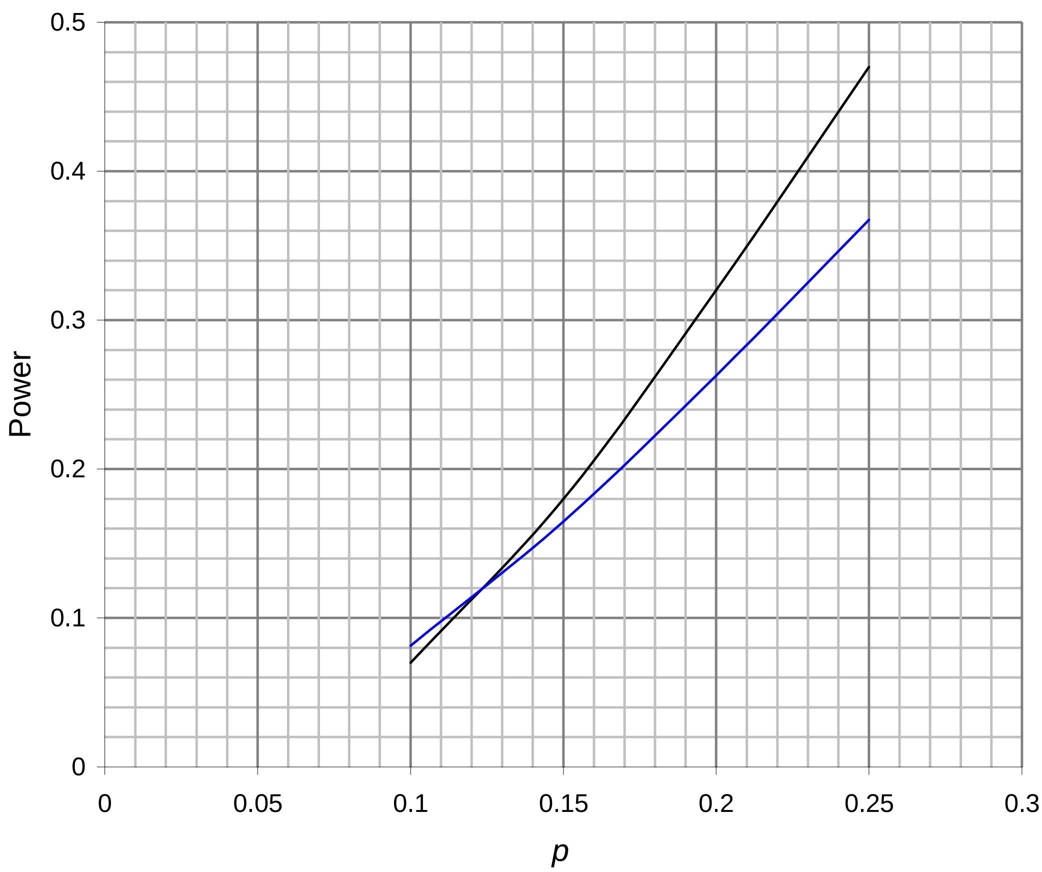
Question Number	Scheme	Marks
Q1 (a)	$H_0: \sigma_1^2 = \sigma_2^2,\ H_1: \sigma_1^2 \neq \sigma_2^2$	B1
	critical values $F_{6,7} = 3.87 \left(\frac{1}{F_{6,7}} = 0.258\right)$	B1
	$\frac{s_2^2}{s_1^2} = \frac{5.2^2}{4.1^2}; = 1.61 \quad \left(\frac{s_1^2}{s_2^2} = \frac{4.1^2}{5.2^2} = 0.622\right)$	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)	$Sp^2 = \frac{7 \times 4.1^2 + 6 \times 5.2^2}{7+6} = 21.53\ldots$	M1A1
	t_{13}=3.012	B1
	99% CI = $(17.9 - 15.9) \pm 3.012 \times \sqrt{21.53} \times \sqrt{\frac{1}{8}+\frac{1}{7}}$	M1A1ft
	= $\pm$(9.23, -5.233), [or accept: [0,9.23] or [-9.23,0]] awrt 9.23, -5.23	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)
		[13]
	Notes B1 Allow $\sigma_1 = \sigma_2$ and $\sigma_1 \neq \sigma_2$ B1 must match their F 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 for $(17.9 - 15.9) \pm$ t 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	

Question Number	Scheme	Marks
Q2 (a)	The differences in the mean heart rates are normally distributed.	B1 (1)
(b)	D = standing up – lying down	
	H_0: $\mu_D = 5$ H_1: $\mu_D > 5$	B1
	d: 9, 6, 4, 2, 8, 9, 3, 5, 7, 7	M1
	$\bar{d} = 6$; $s_d = \sqrt{\frac{414 - 10 \times 36}{9}} = 2.45$	M1;M1
	$t_9 = \frac{6-5}{2.45/\sqrt{10}}$ =1.29	M1A1
	$t_9(5\%) = 1.833$	B1
	insignificant. There is no evidence to suggest that heart rate rises by more than 5 beats when standing up.	A1 ft (8)
		[9]
	Notes must have "The differences in (mean heart rate) are normally distributed) B1 both correct allow μ_D -5 >0 (μ_D = -5 H_1: μ_D < -5) M1 finding differences M1 finding $\bar{d}$ M1 $\sqrt{\frac{\sum d^2 - 10 \times (\bar{d})^2}{9}}$ o.e M1 $\pm\left(\frac{6-5}{s_d/\sqrt{10}}\right)$ need to see full expression with numbers in A1 awrt $\pm$1.29 . B1 $\pm$1.833 only A1 ft their CV and t. Need context. Heart rate and 5 beats	

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

Question Number	Scheme	Marks
(f)	**i** intersection 0.12 – 0.13 “their graphs intersection”	B1ft
	ii if $p > 0.12$ the deputy’s test is more powerful.	B1 (2)
(g)	More powerful for $p < 0.12$ and p unlikely to be above 0.12	
	Allow it would cost more/take longer/more to sample	B1 (1)
		[12]
	Notes (a) M1 for finding P (X>1) A1 awrt 0.0226 (b) M1 for 1-P(0) – P(1) M1 for $1 – (1 – p)^5 – 5(1 – p)^4p$ A1 cso (a) M1 for finding P(Y > 2) A1 awrt0.0115 (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	Marks
Q4 (a)	$\bar{x} = \frac{291}{15} = 19.4 \quad s = \sqrt{\frac{5968 - 15\bar{x}^2}{14}} = 4.800$	M1M1
	i $t_{14} = 2.145$	B1
	95% CI $= 19.4 \pm 2.145 \times \frac{4.800}{\sqrt{15}}$	M1 A1ft
	$= (16.7, 22.1)$	A1A1
	ii 95% CI is given by	
	$\frac{14 \times 4.800^2}{26.119} < \sigma^2 < \frac{14 \times 4.800^2}{5.629}$	M1 B1B1
	(12.4, 57.3) accept 12.3	A1A1 (12)
(b)	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. $\frac{23-22.1}{\sqrt{57.3..}} = 0.124$	M1M1
	$P(Z > 0.124) = 1 - 0.5478$	M1
	$= 0.4522$	A1 (4)
		[16]
	Notes (a)(i) M1 $\frac{291}{15}$ M1 $\sqrt{\frac{5968 - 15\bar{x}^2}{14}}$ B1 2.145 M1 $(19.4) \pm t \times \frac{\text{"their s"}}{\sqrt{15}}$ A1ft $19.4 \pm 2.145 \times \frac{\text{"their s"}}{\sqrt{15}}$ A1 awrt 16.7 A1 awrt 22.1 (ii) M1 $\frac{14 \times s^2}{\chi^2}$ B1 26.119 B1 5.629 A1 awrt12.4/12.3 A1 awrt 57.3 (b) M1 use of highest mean and sigma M1 standardising using values of mean and sigma from intervals M1 finding 1 – P(z > their value) A1 awrt 0.45	

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

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

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

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