GCE MARKING SCHEME

SUMMER 2016

Mathematics – S2
0984/01

INTRODUCTION

This marking scheme was used by WJEC for the Summer 2016 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

GCE Mathematics - S2
Summer 2016 Mark Scheme

Ques	Solution	Mark	Notes
1(a)	$E(W) = 6$	**B1**	
	$E(X^2) = \text{Var}(X) + [E(X)]^2 = 6$	**M1A1**	
	$E(Y^2) = \text{Var}(Y) + [E(Y)]^2 = 12$	**A1**	
	$\text{Var}(W) = E(X^2)E(Y^2) - [E(X)E(Y)]^2$	**M1A1**	
	$= 36$		
(b)	The possibilities are (1,4); (2,2); (4,1) si	**B1**	
	$\Pr = 2e^{-2} \times \frac{3^4}{4!}e^{-3} + \frac{2^2}{2!}e^{-2} \times \frac{3^2}{2!}e^{-3} + \frac{2^4}{4!}e^{-2} \times 3e^{-3}$	**M1A1**	Award the M1 for multiplying and adding Poisson probabilities. Accept use of tables
	$= 0.12$	**A1**	
2(a)	$\bar{x} = \frac{637.2}{10} = 63.7(2)$	**B1**	M0 no working
	SE of $\bar{x} = \frac{1.9}{\sqrt{10}}$ $(0.6008\ldots)$	**M1A1**	
	95% confidence interval limits are $63.7(2) \pm 1.96 \times 0.6008...$	**M1A1**	
	giving [62.5,64.9]	**A1**	
(b)	Width of 95% CI = $2 \times 1.96 \times \frac{1.9}{\sqrt{n}} = 1$	**M1A1**	FT their z from (a)
	$n = 55.47\ldots$	**A1**	
	Minimum $n = 56$ cao	**A1**	
3(a)	Upper quartile = $40 + 0.674(5) \times 2.5$	**M1**	M0 no working
	$= 41.7$	**A1**	
(b)(i)	Let X=weight of a male, Y=weight of a female		
	Let $U = X_1 + X_2 + X_3 + Y_1 + Y_2$		
	$E(U) = 3 \times 40 + 2 \times 32 = 184$	**B1**	
	$\text{Var}(U) = 3 \times 2.5^2 + 2 \times 1.5^2 = 23.25$	**B1**	
	$z = \frac{185 - 184}{\sqrt{23.25}} = 0.21$	**M1A1**	
	Prob = 0.4168	**A1**	Accept 0.417
(ii)	Let $W = X_1 + X_2 + X_3 - 2(Y_1 + Y_2)$	**M1**	
	$E(W) = 3 \times 40 - 4 \times 32 = -8$	**A1**	
	$\text{Var}(W) = 3 \times 2.5^2 + 8 \times 1.5^2 = 36.75$	**M1A1**	
	$z = \frac{8}{\sqrt{36.75}} = 1.32$	**m1A1**	
	Prob = 0.9066	**A1**	Accept 0.907

Ques	Solution	Mark	Notes
4(a)	Under H_0, $E(\bar{X}-\bar{Y})=0$	**B1**	
	$\text{Var}(\bar{X}-\bar{Y})=\frac{1.5^2}{8}+\frac{2.5^2}{12}\left(=0.802...\right)$ (77/96)	**B1**	
	H_1 is accepted if		
	$\frac{\lvert\bar{X}-\bar{Y}\rvert}{\sqrt{0.802...}}>1.645$	**M1A1**	
	$\lvert\bar{X}-\bar{Y}\rvert>1.473$	**A1**	Accept 1.47
	So $k = 1.473$		
(b)(i)			
	Now, $E(\bar{X}-\bar{Y})=0.5$ si	B1	FT k and variance
	H_0 is accepted if $\lvert\bar{X}-\bar{Y}\rvert\le 1.473$, ie	**M1**	
	$-1.473\le\bar{X}-\bar{Y}\le 1.473$	**A1**	
	$z_1=\frac{1.473-0.5}{\sqrt{0.802}}=1.09$	**M1A1**	Accept 1.08
	$z_2=\frac{-1.473-0.5}{\sqrt{0.802}}=-2.20$	**A1**	
	Required probability = 0.8621 – 0.0139	**m1**	Accept 0.8599 – 0.0139
(ii)	= 0.848	**A1**	Accept 0.846
	An appropriate comment, eg The test is unlikely to detect small differences. This is a very high error probability.	**B1**	FT probabilities greater than 0.5
5(a)(i)	$H_0: p=0.7; H_1: p<0.7$	**B1**	
(ii)	Let X denote number of seeds which germinate.		
	Under H_0, X is B(50,0.7) si	**B1**	
	p-value = P($X \le 32$)	**B1**	
	Let Y denote number of non-germinating seeds.		
	Under H_0, Y is B(50,0.3) si	**B1**	
	p-value = P($Y \ge 18$)	**M1**	
	= 0.2178	**A1**	
	Insufficient evidence to reject the seed manufacturer's claim.	**B1**	FT the p-value if > 0.05
(b)	Under H_0, X is now B(500,0.7) ≈ N(350,105) si	**B1B1**	B1 mean, B1 variance
	Test statistic = $\frac{329.5-350}{\sqrt{105}}$	**M1A1**	Award M1A0 for incorrect or no continuity correction but FT for following marks No cc, $z = -2.05$, $p = 0.0202$ Wrong cc, $z = -2.10$, $p = 0.0179$
	= – 2.00	**A1**	
	p-value = 0.0227 or 0.0228	**A1**	
	Strong evidence to conclude that the germination rate is less than 0.7	**B1**	FT the p-value if < 0.05

Ques	Solution	Mark	Notes
6(a)	$P(Y < 8) = P(X > 12)$ $= 0.8$	**M1** **A1**	Award the M1 for stating that Y is uniform on [0,10]
(b)(i)	$Y = 20 - X$	**B1**	
(ii)	$P(XY > 64) = P[X(20 - X) > 64]$ $= P(X^2 - 20X + 64 < 0)$ The critical values are 4 and 16 OR $P[(X-4)(X-16)] < 0$ The required region is $X < 16$	**M1** **A1** **A1** **A1**	
(c)	Prob = 0.6	**A1**	
	EITHER Prob density of X is $f(x) = 0.1$ $(10 < x < 20)$ si	**B1**	
	$E(XY) = \int_{10}^{20} (20x - x^2) \times \frac{1}{10}\,dx$	**M1A1**	Limits may be left until the next line
	$= \frac{1}{10}\left[10x^2 - \frac{x^3}{3}\right]_{10}^{20}$ $= 66.7$ (200/3)	**A1** **A1**	
	OR $E(XY) = 20E(X) - E(X^2)$ $E(X) = 15$ $E(X^2) = \text{Var}(X) + [E(X)]^2$ $= 100/12 + 225$ (700/3) $E(XY) = 66.7$ (200/3)	**(M1)** **(B1)** **(M1)** **(A1)** **(A1)**	