GCE MARKING SCHEME

SUMMER 2017

MATHEMATICS - S3
0985-01

INTRODUCTION

This marking scheme was used by WJEC for the 2017 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.

S3 – June 2017 – Markscheme

Ques	Solution	Mark	Notes
1	$\bar{x} = 59.1$ si	**B1**	
	Var estimate = $\frac{349425}{99} - \frac{5910^2}{100 \times 99} = 1.4545...(16/11)$	**M1A1**	
	(Accept division by 100 which gives 1.44)		
	99% confidence limits are		
	$59.1 \pm 2.576\sqrt{1.4545/100}$	**M1A1**	M0 if 100 or √ omitted, A1 correct *z*
	giving [58.8,59.4] cao	**A1**	
2(a)	Let *S* denote the score on one of the dice. Then,		
	$P(S \le x) = \frac{x}{6}$ for $x = 1,2,3,4,5,6$	**M1**	
	So		
	$P(X \le x)$ = P(All three scores $\le x$)	**A1**	
	$= \left(\frac{x}{6}\right)^3$		Convincing
(b)	$P(X = x) = P(X \le x) - P(X \le x-1)$	**M1**	
	$= \frac{x^3 - (x-1)^3}{216} \quad \left(\frac{3x^2 - 3x + 1}{216}\right)$	**A1**	
(c)	A valid attempt at considering relevant probabilities.	**M1**	
	Most likely value = 6	**A1**	
3	$\bar{x} = 41.1; \bar{y} = 34.9$	**B1**	
	$s_x^2 = \frac{84773}{49} - \frac{2055^2}{49 \times 50} = 6.3775...(625/98)$	**M1A1**	
	$s_y^2 = \frac{61121}{49} - \frac{1745^2}{49 \times 50} = 4.5$	**A1**	
	[Accept division by 50 giving 6.25 and 4.41]		
	SE = $\sqrt{\frac{6.3775..}{50} + \frac{4.5}{50}}$ = 0.4664... (0.4617…)	**M1A1**	M0 no working
	$z = \frac{41.1 - 34.9 - 5}{0.4664..}$	**m1A1**	
	=2.57 (2.60)	**A1**	
	p-value = 0.005	**A1**	
	Very strong evidence in support of Mair's belief (namely that the difference in the mean weights of male and female dogs is more than 5kg)	**A1**	FT the *p*-value if less than 0.05

Ques	Solution	Mark	Notes
4(a)	$\hat{p} = 0.32$ si ESE = $\sqrt{\frac{0.32 \times 0.68}{75}}$ (= 0.05386..) si 95% confidence limits are $0.32 \pm 1.96 \times 0.05386..$ giving [0.21,0.43]	**B1** **M1A1** **M1A1** **A1**	M0 no working A1 correct z
(b)	The statement is incorrect because you cannot make a probability statement about a constant interval containing a constant value. EITHER The correct interpretation is that the calculated interval is an observed value of a random interval which contains the value of p with probability 0.95. OR If the process could be repeated a large number of times, then (approx) 95% of the intervals produced would contain p.	**B1** **B1** **(B1)**	
5(a)	$\sum x = 306; \sum x^2 = 10407.52$ UE of μ = 34 UE of $\sigma^2 = \frac{10407.52}{8} - \frac{306^2}{72}$ = 0.44	**B1B1** **B1** **M1** **A1**	No working need be seen M0 division by 9 Answer only no marks
(b)	DF = 8 si t-value = 2.306 95% confidence limits are $34 \pm 2.306 \times \sqrt{\frac{0.44}{9}}$ giving [33.5,34.5] cao	**B1** **B1** **M1** **A1**	M0 for using Z FT from (a)

Ques	Solution	Mark	Notes
6(a)	$S_{xy} = 2744 - 140 \times 107.3/6 = 240.33$	**B1**	M0 no working
	$S_{xx} = 3850 - 140^2/6 = 583.33$	**B1**	
	$b = \dfrac{240.33}{583.33} = 0.412$	**M1** **A1**	
	$a = \dfrac{107.3 - 0.412 \times 140}{6} = 8.27$	**M1** **A1**	
(b)(i)	$H_0: \beta = 0.4$; $H_1: \beta \neq 0.4$	**B1**	
(ii)	SE of $b = \dfrac{0.2}{\sqrt{583.33}}$ (0.00828..)	**M1A1**	
	Test statistic = $\dfrac{0.412 - 0.4}{0.00828}$	**m1A1**	
	= 1.45	**A1**	
	Tabular value = 0.0735	**A1**	
	p-value = 0.147	**A1**	Award for doubling line above
(iii)	The data support Emlyn's belief.	**A1**	FT the p-value

Ques	Solution	Mark	Notes
7(a)(i)	$E(X) = p + \frac{2(1-p)}{3} + \frac{3(1-p)}{3} + \frac{4(1-p)}{3}$	**M1**	
	$= \frac{3p+2-2p+3-3p+4-4p}{3}$	**A1**	
	$= 3-2p$	**A1**	
(ii)	$E(X^2) = p + (2^2+3^2+4^2)\frac{(1-p)}{3}$	**M1A1**	$\left(\frac{29}{3} - \frac{26}{3}p\right)$
	$\text{Var}(X) = p + (2^2+3^2+4^2)\frac{(1-p)}{3} - (3-2p)^2$	**A1**	
	$= \frac{2}{3} + \frac{10}{3}p - 4p^2$	**A1**	
	$= \frac{2}{3}(1-p)(1+6p)$		
(b)(i)	$E(U) = \frac{3-E(X)}{2}$	**M1**	M0 if no E
	$= \frac{3-(3-2p)}{2}$	**A1**	
	$= p$		
	(Therefore U is an unbiased estimator)		
(ii)	$\text{Var}(U) = \frac{1}{4}\text{Var}(\bar{X})$	**M1**	
	$= \frac{\frac{2}{3}(1-p)(1+6p)}{4n}$	**A1**	
(c)(i)	Y is $\text{B}(n,p)$	**B1**	
(ii)	$\text{E}(V) = \frac{E(Y)}{n}$	**M1**	M0 if no E
	$= \frac{np}{n} = p$	**A1**	
	(Therefore V is an unbiased estimator)		
(iii)	$\text{Var}(V) = \frac{\text{Var}(Y)}{n^2}$	**M1**	
	$= \frac{p(1-p)}{n}$ oe	**A1**	

Ques	Solution	Mark	Notes
(d)	$\dfrac{\text{Var}(U)}{\text{Var}(V)} = \dfrac{\frac{2}{3}(1-p)(1+6p)}{4n} \div \dfrac{p(1-p)}{n}$ $= \dfrac{1+6p}{6p}$ oe cao > 1 oe Therefore V is the better estimator.	**M1** **A1** **A1** **A1**	No FT for incorrect ratio