Rewarding Learning

ADVANCED
General Certificate of Education
2014

Mathematics

Assessment Unit S4
assessing
Module S2: Statistics 2

[AMS41]

MONDAY 23 JUNE, MORNING

MARK SCHEME

GCE ADVANCED/ADVANCED SUBSIDIARY (AS) MATHEMATICS

Introduction

The mark scheme normally provides the most popular solution to each question. Other solutions given by candidates are evaluated and credit given as appropriate; these alternative methods are not usually illustrated in the published mark scheme.

The marks awarded for each question are shown in the right-hand column and they are prefixed by the letters **M**, **W** and **MW** as appropriate. The key to the mark scheme is given below:

M indicates marks for correct method.

W indicates marks for working.

MW indicates marks for combined method and working.

The solution to a question gains marks for correct method and marks for an accurate working based on this method. Where the method is not correct no marks can be given.

A later part of a question may require a candidate to use an answer obtained from an earlier part of the same question. A candidate who gets the wrong answer to the earlier part and goes on to the later part is naturally unaware that the wrong data is being used and is actually undertaking the solution of a parallel problem from the point at which the error occurred. If such a candidate continues to apply correct method, then the candidate's individual working must be followed through from the error. If no further errors are made, then the candidate is penalised only for the initial error. Solutions containing two or more working or transcription errors are treated in the same way. This process is usually referred to as "follow-through marking" and allows a candidate to gain credit for that part of a solution which follows a working or transcription error.

Positive marking:

It is our intention to reward candidates for any demonstration of relevant knowledge, skills or understanding. For this reason we adopt a policy of **following through** their answers, that is, having penalised a candidate for an error, we mark the succeeding parts of the question using the candidate's value or answers and award marks accordingly.

Some common examples of this occur in the following cases:

(a) a numerical error in one entry in a table of values might lead to several answers being incorrect, but these might not be essentially separate errors;

(b) readings taken from candidates' inaccurate graphs may not agree with the answers expected but might be consistent with the graphs drawn.

When the candidate misreads a question in such a way as to make the question easier only a proportion of the marks will be available (based on the professional judgement of the examining team).

			Marks	AVAILABLE MARKS
1	**(i)**	$r = \dfrac{36\,933 - \dfrac{460 \times 760}{10}}{\sqrt{\left(23\,666 - \dfrac{460^2}{10}\right)\left(59\,860 - \dfrac{760^2}{10}\right)}}$	M1 MW3	
		$= \dfrac{1973}{\sqrt{2506 \times 2100}}$		
		$= 0.860$	W1	
	(ii)	Moderately strong positive correlation between fitness and attitude to healthy eating	M1	6
2		$\overline{X}_{20} \sim \mathrm{N}\left(350, \dfrac{125}{20}\right) = \mathrm{N}(350, 6.25) = \mathrm{N}(350, 2.5^2)$	MW1	
		$\mathrm{P}(348 < \overline{X}_{20} < 353) = \mathrm{P}(-0.8 < Z < 1.2)$	MW2	
		$= \Phi(0.8) + \Phi(1.2) - 1$	M1	
		$= 0.7881 + 0.8849 - 1$	MW2	
		$= 0.673$	W1	7
3	**(i)**	$n = 75 \quad \Sigma fx = 1299.5 \quad \Sigma fx^2 = 22\,792.75$	MW1	
		$\hat{\mu} = \bar{x} = 17.33 \quad \hat{\sigma}^2 = 3.74$	MW2	
	(ii)	$\text{C. I.} = \bar{x} \pm 1.96 \dfrac{\hat{\sigma}}{\sqrt{n}}$	M1 MW2	
		$\text{C. I.} = 17.33 \pm 1.96 \dfrac{\sqrt{3.74}}{\sqrt{75}}$		
		$= (16.89, 17.76)$	W2	
	(iii)	Any acceptable assumption with respect to basic principle.	M1	9
4	**(i)**	$R = a + bT$		
		$b = \dfrac{497\,450 - \dfrac{450 \times 6752}{6}}{35\,500 - \dfrac{450^2}{6}}$	MW1 MW1	
		$b = -5.11$	W1	
		$a = \bar{R} - b\bar{T} = \dfrac{6752}{6} - (-5.11)\dfrac{450}{6} = 1508.9$	M1 W1	
		$R = 1510 - 5.11T$	W1	
	(ii)	$\hat{R} = 1508.9 - 5.11 \times 75 = 1125.33 = 1130\,\Omega$ (3 s.f.)	M1 W1	8

			AVAILABLE MARKS
5	$H_0 : \mu = 85$	M1	
	$H_1 : \mu \neq 85$	M1	
	Two-tailed z-test	M1	
	$z_{crit} = \pm 1.96$	M1	
	$z_{test} = \dfrac{84.7 - 85}{\dfrac{0.8}{\sqrt{100}}}$	MW1 MW1	
	$= -3.75$	W1	
	Since z_{test} lies in the critical region we reject H_0	M1	
	and conclude that there is sufficient evidence at 5% to suggest that the mean contents of active ingredients in the capsules is not 85	M1	9
6	Taking spring length (l) as the *response or dependent* variable	M1	
	and taking mass (m) as the *controlled or independent* variable.	M1	
	The mass values will be *exact* values	M1	
	whilst the spring length values will be subject to *variation*.	M1	
	Record a set of pairs of values and compute regression equation accordingly.	M1	5
7	**(i)** Let X be r.v. "the mass of cookies in a packet of standard-sized cookies".		
	Then $X \sim \mathrm{N}(6 \times 30, 6 \times 2^2) = (180, 24)$	MW2	
	$\mathrm{P}(X > 185) = \mathrm{P}(Z > 1.021)$	MW1	
	$= 1 - \Phi(1.021)$	M1	
	$= 1 - 0.8463$	MW1	
	$= 0.1537 = 0.154$ (3 s.f.)	W1	
	(ii) Let Y be r.v. "the mass of a large-sized cookie".		
	Then $Y \sim \mathrm{N}(50, 3^2) = \mathrm{N}(50, 9)$		
	Let D be r.v. "the difference between the mass of cookies in a packet of standard-sized cookies and four times the mass of a large-sized cookie." Then $D = X - 4Y$	M1	
	$D \sim \mathrm{N}(180 - 4 \times 50, 24 + 4^2 \times 9) = \mathrm{N}(-20, 168)$	MW3	
	$\mathrm{P}(D < -10) = \mathrm{P}(Z < 0.772)$	MW1 W1	
	$\Phi(0.772) = 0.7798$	W1	13

				AVAILABLE MARKS
8	**(i)**	$H_0 : \mu = 5$	M1	
		$H_1 : \mu \neq 5$	M1	
		Two-tailed *t*-test with 10 degrees of freedom	M1 MW1	
		$t_{\text{crit}} = \pm 2.228$	W1	
		$\bar{x} = \dfrac{52.5}{11} = 4.77 \quad \hat{\sigma}^2 = \dfrac{1}{10}\left(252 - \dfrac{52.5^2}{11}\right) = 0.143$	MW1 M1 W1	
		Test statistic $= \dfrac{4.77 - 5}{\sqrt{\dfrac{0.143}{11}}}$	MW1 MW1	
		Test statistic $= -1.99$	W1	
		As value of test statistic is not in critical region we do not reject H_0,	M1	
		and conclude that there is not sufficient evidence at 5% level to suggest that the mean weight in the bags is not 5 kg.	M1	
	(ii)	$H_0 : \mu = 5$		
		$H_1 : \mu < 5$	M1	
		One-tailed *t*-test with 10 degrees of freedom	W1	
		$t_{\text{crit}} = -1.812$	W1	
		As value of test statistic is in critical region we reject H_0,	M1	
		and conclude that there is sufficient evidence at 5% level to suggest that the mean weight in the bags is less than 5 kg.	M1	18
			Total	**75**