



**ADVANCED**  
**General Certificate of Education**  
**2019**

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**Mathematics**

Assessment Unit S4  
*assessing*  
Module S2: Statistics 2

**[AMS41]**

**FRIDAY 14 JUNE, AFTERNOON**

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**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).

		AVAILABLE MARKS
1	<p>Excludes those who bought their cars from dealers outside Bangor area but live in Bangor</p> <p>Excludes those who bought their cars in private deals</p> <p>Many people show apathy to mail drops</p> <p>Most likely will get the dissatisfied as they are usually quicker to reply</p> <p>People may have sold their cars on</p> <p>People may have bought their cars more than 3 years ago or any valid reason</p>	M4 4
2	<p>(i) <math>\bar{X}_5</math>      mean = 200g</p> <p style="padding-left: 100px;">Variance = <math>\frac{25}{5} = 5g^2</math></p> <p>(ii) <math>\bar{X}_5 = N(200, 5)</math></p> <p>Prob (<math>\bar{X}_5 &gt; 198</math>)</p> <p>= <math>P\left(z &gt; \frac{198 - 200}{\sqrt{5}}\right)</math></p> <p>= <math>P(z &gt; -0.8944)</math></p> <p>= <math>P(z &lt; 0.8944)</math></p> <p>= 0.8144</p> <p>= 0.814 (3 SF)</p>	W1 MW1  M1 W1  W1 W1  6
3	<p>Confidence Interval <math>\bar{x} \pm 1.96 \frac{\sigma'}{\sqrt{n}}</math></p> <p><math>\bar{x} - 1.96 \frac{\sigma'}{10} = 159.02</math></p> <p><math>\bar{x} + 1.96 \frac{\sigma'}{10} = 160.98</math></p> <p><math>\bar{x} = 160</math></p> <p><math>1.96 \frac{\sigma'}{10} = 0.98</math></p> <p><math>\sigma' = 5</math></p>	M1 W1 W1 W1 M1 W1  6
4	<p><math>H_0: \mu = 60</math></p> <p><math>H_1: \mu &gt; 60</math></p> <p>One tailed at 5%</p> <p><math>z_{crit} = 1.645</math></p> <p><math>z = \frac{62.8 - 60}{13.2/\sqrt{50}} = 1.4999</math></p> <p><math>1.4999 &lt; 1.645</math></p> <p>There is insufficient evidence at the 5% level to not accept <math>H_0</math></p> <p><math>\therefore</math> Claim of longer journey not justified.</p>	M1 M1 M1 M1 MW1 M1 M1  7

5	<p>(i) Variable <math>X = A + A + A + B + B</math>  <math>\bar{X} = 3 \times 40 + 2 \times 25 = 170 \text{ mm}</math>  <math>\text{Var}[X] = 3 \times 0.07 + 2 \times 0.02 = 0.25 \text{ mm}^2</math>  <math>X \sim N[170, 0.25]</math>  <math>P\{169.2 \leq X \leq 170.8\} = P\left(\frac{-0.8}{0.5} \leq z \leq \frac{0.8}{0.5}\right)</math>  <math>= P(-1.6 \leq z \leq 1.6)</math>  <math>= 1 - 2(1 - 0.9452) = 0.8904 = 0.890 \text{ (3 SF)}</math></p>	M1 MW1 MW1 M1 W1 W1	AVAILABLE MARKS						
(ii)	<table border="1" style="border-collapse: collapse; width: 100%;"> <tr> <td style="padding: 2px;">Profit</td> <td style="padding: 2px; text-align: center;">4</td> <td style="padding: 2px; text-align: center;">-5</td> </tr> <tr> <td style="padding: 2px;">Prob</td> <td style="padding: 2px; text-align: center;">0.8904</td> <td style="padding: 2px; text-align: center;">0.1096</td> </tr> </table> <p>Expected Profit = <math>4 \times 0.8904 - 5 \times 0.1096 = \text{£}3.01</math></p>	Profit		4	-5	Prob	0.8904	0.1096	M1 W1
Profit	4	-5							
Prob	0.8904	0.1096							
8									
6	<p>(a) (i) <math>X = N(30, 16)</math>  <math>S = 3X</math>  <math>E(S) = 3E(X) = 90</math>  <math>\text{Var}(S) = 9\text{Var}(X) = 144</math>  <math>S \sim N[90, 144]</math>  <math>P(3X &gt; 100) = P\left(\frac{S-90}{12} &gt; \frac{100-90}{12}\right)</math>  <math>= P(z &gt; 5/6) = 1 - 0.7975 = 0.2025</math>  <math>= 0.203 \text{ (3 SF)}</math></p> <p>(ii) <math>T = X_1 + X_2 + X_3</math>  <math>E(T) = 3E[X] = 90</math>  <math>\text{Var}(T) = 3\text{Var}[X] = 48</math>  <math>T \sim N[90, 48]</math>  <math>P(T &gt; 100) = P\left(\frac{T-90}{\sqrt{48}} &gt; \frac{100-90}{\sqrt{48}}\right)</math>  <math>= P(z &gt; 1.443)</math>  <math>= 1 - 0.9255 = 0.0745</math>  <math>= 0.075 \text{ (3 SF)}</math></p>	MW1 M1 W1 M1 W1 W1 MW1 M1 W1 M1 W1 W1	AVAILABLE MARKS						
(b)	<p><math>\bar{X}_{80} \sim N\left[63.2, \frac{20}{80}\right] = N[63.2, 0.25]</math>  <math>P(\bar{X}_{80} &lt; 62.5) = P\left(z &lt; \frac{62.5 - 63.2}{\sqrt{0.25}}\right)</math>  <math>= P(z &lt; -1.4) = 1 - 0.9192 = 0.0808 \text{ (3 SF)}</math></p>	MW1 MW1 MW1 M1 W1							
17									

			AVAILABLE MARKS		
7	$\Sigma d = 23$ $\Sigma d^2 = 207$ $\bar{d} = 2.3$ $s^2 = \frac{\Sigma d^2 - n\bar{d}^2}{n-1}$ $= \frac{207 - 52.9}{9}$ $= 17.12$ $H_0$ : There is no change in journey time, i.e. $\mu = 0$ $H_1$ : There is a change in journey time, i.e. $\mu \neq 0$ $t = \frac{\bar{d}}{s/\sqrt{n}} = \frac{2.3}{\sqrt{\frac{17.12}{10}}} = 1.76$ 2 tailed test $t_9 = 2.262$ There is insufficient evidence at the 5% level to not accept $H_0$ i.e. no change in journey time	M1 W1 M1  W1 MW1 MW1 M1 W1 MW1 MW1 M1 M1	12		
8	(i) Correlation $r = \frac{\Sigma xy - n\bar{x}\bar{y}}{\sqrt{(\Sigma x^2 - n\bar{x}^2)(\Sigma y^2 - n\bar{y}^2)}}$ $= \frac{20305 - 8 \times 26.875 \times 90.875}{\sqrt{(6061 - 8 \times 26.87^2)(68265 - 8 \times 90.875^2)}}$ $= \frac{766.875}{788.67} = 0.972$ (3 SF)	M1 W2 W1		15	
	(ii) $y = a + bx$ $b = \frac{\Sigma xy - n\bar{x}\bar{y}}{\Sigma x^2 - n\bar{x}^2}$ $\bar{x} = \frac{\Sigma x}{n} = 26.875$ $\bar{y} = \frac{727}{8} = 90.875$ $b = \frac{20305 - 8 \times 26.875 \times 90.875}{6061 - 8 \times (26.875)^2} = \frac{766.875}{282.875} = 2.711$ $a = \bar{y} - b\bar{x} = 90.875 - 2.711 \times 26.875 = 18.02$ $y = 18.0 + 2.71x$	M1 W2 W1 M1 W1 W1	15		
	(iii) Income for $x$ toys = $\text{£}4x$ Production cost from regression equation $y = 18.02 + 2.711x$ $4x = 18.02 + 2.711x$ $x = 14$ company starts to make a profit at $x = 14$	MW1 M1 W1 M1			15
		Total			