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# Level 3 Certificate

# Mathematical Studies

1350/2A Statistical Techniques

Final Mark scheme

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1350

June 2017

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Version/Stage: v1.0

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Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from [aqa.org.uk](http://aqa.org.uk)

## Key to mark scheme abbreviations

M	mark is for method
m or dM	mark is dependent on one or more M marks and is for method
A	mark is dependent on M or m marks and is for accuracy
B	mark is independent of M or m marks and is for method and accuracy
E	mark is for explanation
✓ or ft or F	follow through from previous incorrect result
CAO	correct answer only
CSO	correct solution only
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
A2,1	2 or 1 (or 0) accuracy marks
-x EE	deduct x marks for each error
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
c	candidate
sf	significant figure(s)
dp	decimal place(s)

### No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

**Otherwise we require evidence of a correct method for any marks to be awarded.**

Q	Answer	Mark	Comments
1(a)	<p><b>Errors</b></p> <p>Information from one operator is missing</p> <p>Inappropriate use of currency notation eg £189.99p with both the pence and the pounds symbol.</p> <p>The one-off payment for Operator D may have been wrong/possibly a decimal point is missing</p> <p>No time frame for rental cost/contract</p>	E2	<p>E1 for each valid error</p> <p>Ignore any extras even if not valid</p>
	<p><b>Improvement</b></p> <p>Name the operator</p> <p>Add information from the missing operator</p> <p>Remove the p sign when £ sign is used</p> <p>Replace the one-off payment for Operator D with a correct value/£99.99</p> <p>State if the rental is per month or per year</p> <p>State the duration of the contracts for each operator</p> <p>Add more information on allowances eg minutes, texts, downloads</p> <p>Include a separate table for pay-as-you-go</p>	E2	<p>E1 for each valid suggestion for improvement</p> <p>Ignore any extras even if not valid</p> <p>Condone £99.99p</p>
	<b>Additional Guidance</b>		
	Improvements are independent of errors eg information from one operator is missing, they don't have to state as improvement 'add information from missing operator'		
	Work out how much he will pay overall scores E0		

Q	Answer	Mark	Comments
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<b>1(b)</b>	<b>Alternative method 1</b>		
	37.49 × 24 or 899.(...) or 37.49 × 0.7 or 26.(...)	M1	
	their 899.(...) × 0.7 or 629.(...) or their 26.(...) × 24 or 629.(...) or 629.(...)	M1	
	their 629.(...) + 109.99 or 739.(...)	M1	
	739.8(...) <b>and</b> No or 739.75 <b>and</b> No	A1	AWRT 739.8 Condone 739.85

Q	Answer	Mark	Comments
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<b>1(b)</b>	<b>Alternative method 2</b>		
	37.49 × 24 or 899.(...) or 37.49 × 0.7 or 26.(...)	M1	
	their 899.(...) × 0.7 or 629.(...) or their 26.(...) × 24 or 629.(...) or 629.(...)	M1	
	700 – their 629.(...) or 70.(...) <b>and</b> compares with 109.99	M1	

	70.(...) < 109.99 <b>and</b> No	A1	

<b>1(b)</b>	<b>Alternative method 3</b>		
	700 – 109.99 or 590.01	M1	
	37.49 × 0.7 or 26.(...)	M1	
	their 590.01 ÷ their 26.(...) or 22.(...) or their 590.01 ÷ 24 or 24.(...)	M1	
	22.5 <b>and</b> No or 26.24 <b>and</b> 24.58 <b>and</b> No	A1	
	<b>Additional Guidance</b>		

Q	Answer	Mark	Comments
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<b>2(a)</b>	80 000	B1	
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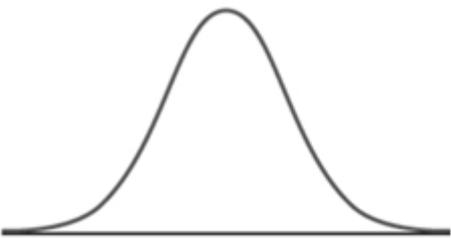
<b>2(b)</b>	<b>Always Young</b>		
	$\frac{16.9 - 13.7}{16.9} (\times 100\%)$ or <u>13.7</u> ( $\times 100\%$ ) <b>and</b> compares with 100%	M1	OE SC2 for $\frac{1}{5} \times 764\ 000 = 152\ 800 \neq 136\ 000$ or $764\ 000 - 152\ 800 = 611\ 200 \neq 628\ 000$

<p>16.9</p> <p>or <math>\frac{4}{5} \times 16.9</math></p>		<p>or <math>\frac{136\,000}{764\,000} (\times 100\%) = 17.8\%</math></p> <p>or <math>\frac{628\,000}{764\,000} (\times 100\%) = 82.2\%</math></p> <p><b>and</b></p> <p>Always Young is wrong/the statement is incorrect/it isn't quite one-fifth/ could be true it's nearly one-fifth</p>
<p>[18.9,19] %</p> <p>or</p> <p>13.5(...) <b>and</b> 13.7 seen</p>	<p>A1</p>	
<p>Always Young is wrong or the statement/headline is incorrect</p> <p>or it isn't quite one-fifth</p> <p>or could be true it's nearly one-fifth</p>	<p>E1</p>	<p>E1 one correct statement/agreement</p> <p>OE</p>
<p><b>Dynamic Youth</b></p>		
<p>Working out the total number men 16-24 or women aged 16-24</p> <p>Men: 362 000 ÷ 0.152</p> <p>or</p> <p>Women: 265 000 ÷ 0.121</p>	<p>M1</p>	<p>This can be implied in the correct number of men/women aged 16-24 given below</p>
<p>Any value within range [2 380 000, 2 400 000]</p>	<p>A1</p>	
<p>Any value within range [2 100 000, 2 200 000]</p>	<p>A1</p>	
<p>Putting their values as a ratio with attempts to simplify it (i.e 1.09:1 etc) or comparing it to 11:10</p>	<p>A1</p>	
<p>Ratio of 1.09:1 calculated and Dynamic Youth is correct/the statement/headline is correct</p>	<p>E1</p>	<p>OE</p>

<b>Additional Guidance</b>	
For Always Young, if candidates use 15.1%/12.2% leading to 19.2(...) % or 15.1%/12.3% leading to 18.5(...) % can score M1 A0 E1	

Q	Answer	Mark	Comments
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<b>2(c)</b>	<p>Any three of</p> <p>Display figures in tables e.g. give the actual figures for each quarter/year rather than the differences</p> <p>Ensure data is accurate before publishing it (eg for 16-24, 362 000 (men) + 265 000 (women) ≠ 628 000)</p> <p>Use a consistent time period throughout (eg for youth long term unemployment, the period was August – October but in all other parts of the briefing paper, references were made for September – November)</p> <p>Improve clarity of definitions</p> <p>Graph needs to be more accurate eg larger scale</p> <p>Sort into categories</p> <p>Axes need to be labelled</p> <p>Use more charts (to make information clearer)</p>	E3	<p>E1 for each valid suggestion</p> <p>Ignore any additional but incorrect suggestions</p> <p>SC1 (for two or three errors identified with no/incorrect suggestions for improvement)</p> <p>OE</p> <p>OE</p>
<b>Additional Guidance</b>			

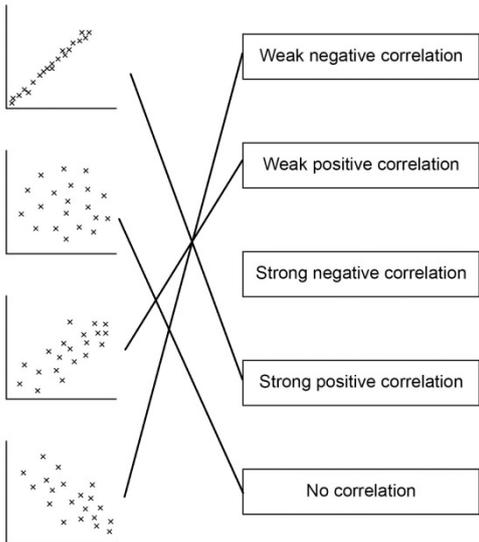
Q	Answer	Mark	Comments
3(a)		B1	

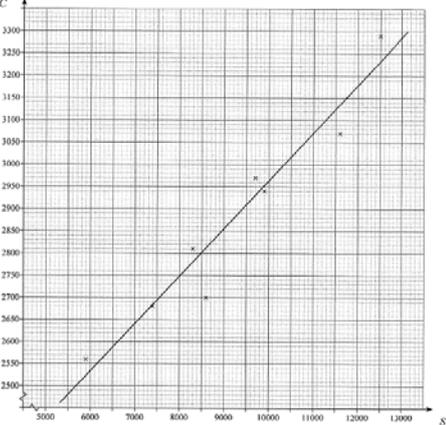
3(b)	$(z =) \frac{M - 65}{11}$ seen	M1	
	$\frac{M - 65}{11} = [0.25, 0.26]$ <b>and</b> attempts to find $M$ by re-arranging the equation or $(67.75, 67.86)$	M1	
	67	A1	cao
	<b>Additional Guidance</b>		
	If candidates use 121 instead of 11 can score M0 M1 A0		

Q	Answer	Mark	Comments
3(c)	$0.5 \times 30 \times 5$ or $15 \times 5$ or 75	M1	
	(£)75 and No or (£)5 more needed	A1	OE
	<b>Additional Guidance</b>		

Q	Answer	Mark	Comments
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3(d)	(z =) $(60 - 65) \div 11$ or $(-) \frac{5}{11}$ or $(-) 0.45(\dots)$	M1	Condone (65 – 60)
	140 $\div$ P(z > their 0.45..) or 140 $\div$ [0.67364, 0.67724]	M1	
	[206, 208]	A1	
	[236, 238]	A1ft	ft their [206, 208] + 30 with at least one M1 scored
	<b>Additional Guidance</b>		
If candidates use 121 instead of 11 they can score M0 M1 A0 A1ft			

Q	Answer	Mark	Comments
4(a)	 <p>Weak negative correlation</p> <p>Weak positive correlation</p> <p>Strong negative correlation</p> <p>Strong positive correlation</p> <p>No correlation</p>	B2	B2 for all four pairs correctly matched B1 for two or three pairs correctly matched
4(b)	<p>pmcc for Jamir → [0.96, 0.97]</p> <p>(Jamir's data shows a) strong positive correlation (so it is possible) or very close to 1</p> <p style="text-align: center;"><b>Additional Guidance</b></p> <p>Correct statement comes from their pmcc for Jamir calculated to be &gt;0.9 but not [0.96, 0.97] can score B0E1</p>	B1  E1	
4(c)	<p>pmcc for Lily → [0.81, 0.82]</p> <p>(Lily's data shows a) positive correlation but not as strong as Jamir's pmcc is closer to 1 or The correlation of Lily's data is not as strong (positive) as for Jamir's</p> <p style="text-align: center;"><b>Additional Guidance</b></p> <p>Correct statement comes from their pmcc for Lily calculated to be &lt;0.9 but not [0.81, 0.82] can score B0E1</p>	B1  E1	

Q	Answer	Mark	Comments
4(d)(i)	All four points correctly plotted.	B2	B2 all four points correctly plotted B1 two or three points correctly plotted
4(d)(ii)	$C = 1893 + 0.107S$	B2	for 1893 accept [1890, 1900] for 0.107 accept [0.106, 0.107] or 0.11 B1 either value correct  Allow $y = 1893 + 0.107x$
	Correct line drawn from at least $S = 6000$ to $S = 12000$  	B2	ft their equation $\pm \frac{1}{2}$ square B2 two points on their $C = 1893 + 0.107S$ <b>and</b> line drawn B1 for at least one correct point identified or plotted
	<b>Additional Guidance</b>		
	For 6000, the coordinates are (6000, 2535)		
	For 12000, the coordinates are (12000, 3177)		
Line has to be drawn for values of $S$ from 6000 to 12000			

Q	Answer	Mark	Comments
4(d)(iii)	<b>Alternative Method 1</b>		
	20 000 $\div$ 7 or [2850, 2860]	M1	
	([2850, 2860] – their 1893) $\div$ their 0.107	M1dep	
	[8630, 9150]	A1ft	ft correct evaluation using their equation
	<b>Alternative Method 2</b>		
	20 000 $\div$ 7 or [2850, 2860]	M1	
	(Draws a line from their [2850, 2860] and) reads value from their regression line or their line of best fit	M1dep	Implied by correct reading
	Correct value from their line	A1ft	$\pm$ ½ square

Q	Answer	Mark	Comments
5(a)	1.5	B1	
5(b)	$(z =)(59 - 59.6) \div \text{their } 1.5 \text{ or } (-) \frac{2}{5}$ or $(-) 0.4$  or $(z =)(59.8 - 59.6) \div \text{their } 1.5 \text{ or } (-) \frac{2}{15}$ or $(-) 0.13(33\dots)$	M1	ft their answer to 5(a) Condone $(59.6 - 59)$ or $(59.6 - 59.8)$
	$(P(z < \text{their } 0.4) =) \text{their } 0.65542$ or $(P(z < \text{their } -0.4) =) \text{their } 0.34458$ or $(P(z < \text{their } 0.13) =) \text{their } 0.55172$ or $(P(z > \text{their } 0.13) =) \text{their } 0.44828$	M1dep	One correct reading
	their $P(-0.4 < z < 0.13)$	M1	OE eg shown diagrammatically on labelled Normal distribution curve or $0.55172 - 0.34458$
	0.20(714)	A1ft	OE  or better, eg 0.21 or 0.207 or 0.208 allow 0.2 if method seen ft their answer to 5(a)

Q	Answer	Mark	Comments
<b>6(a)</b>	<b>Alternative method 1</b>		
	$\frac{35.2 + 41.8}{2}$	M1	Mean/median temperature
	38.5	A1	
	90% value → 1.64(49) or 1.64 seen	B1	1.64(49) can be implied in CI calculation
	their $38.5 - \text{their } 1.64(49) \times \frac{\sigma}{\sqrt{n}} = 35.2$ or their $38.5 + \text{their } 1.64(49) \times \frac{\sigma}{\sqrt{n}} = 41.8$	M1	OE M1 allow one error eg use of $\sqrt{\sigma}$ instead of $\sigma$ for using $n$ instead of $\sqrt{n}$ using $\sigma$ and $n$ at the denominator and numerator
	99% value → 2.57(58) or 2.58 seen	B1	2.57(58) can be implied in CI calculation
	their $38.5 \pm \text{their } 2.57(58) \times (35.2 - \text{their } 38.5) \div - \text{their } 1.64(49)$ or their $38.5 \pm \text{their } 2.57(58) \times (41.8 - \text{their } 38.5) \div \text{their } 1.64(49)$ or their $38.5 \pm \text{their } 2.57(58) \times \text{their } 2.0(\dots)$	M2	M2 for both correct expressions M1 allow one error Note: values must be substituted
	(33.3, 43.7) or $38.5 \pm 5.17$ or $38.5 \pm 5.2$	A1	

Q	Answer	Mark	Comments
6(a)	<b>Alternative method 2</b>		
	$\frac{35.2 + 41.8}{2}$	M1	Mean/median temperature
	38.5	A1	
	90% value → 1.64(49) or 1.64 seen	B1	1.64(49) can be implied in CI calculation
	their 38.5 – their 1.64(49) × $\frac{\sigma}{\sqrt{20}} = 35.2$ or their 38.5 + their 1.64(49) × $\frac{\sigma}{\sqrt{20}} = 41.8$ or $\sigma = 8.97(200..)$ or 9	M1	OE M1 allow one error eg use of $\sqrt{\sigma}$ instead of $\sigma$ for using $n$ instead of $\sqrt{n}$ using $\sigma$ and $n$ at the denominator and numerator
	99% value → 2.57(58) or 2.58 seen	B1	2.57(58) can be implied in CI calculation
	their $38.5 \pm$ their 2.57(58) × their $8.97(200..) \div \sqrt{20}$ or their $38.5 \pm$ their 2.5758 × their 2.0(...)	M2	M2 for both correct expressions M1 allow one error Note: values must be substituted
	(33.3, 43.7) or $38.5 \pm 5.17$ or $38.5 \pm 5.2$	A1	
	<b>Additional Guidance</b>		
	for their 38.5 and $\sigma$ do not allow use of 35.2 or 41.8		
setting up two correct simultaneous linear equations and attempts to solve for the value of $\mu$ can score the first method mark			
allow rounding to 3 sf			

Q	Answer	Mark	Comments
<b>6(b)</b>	37 lies in the given 90% or the calculated 99% confidence interval or accept similar explanation	B1ft	ft their 99% confidence interval if used
	Claim is wrong/incorrect/not supported	E1	
	<b>Additional Guidance</b>		
	Only ft for the B1		