LEVEL 3 CERTIFICATE
Mathematical Studies

1350/2A Statistical Techniques
Mark scheme

1350
June 2016

Version 1.0: Final Mark Scheme

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.

Glossary for Mark Schemes

Examinations are marked in such a way as to award positive achievement wherever possible. Thus, for mathematics papers, marks are awarded under various categories.
If a student uses a method which is not explicitly covered by the mark scheme the same principles of marking should be applied. Credit should be given to any valid methods. Examiners should seek advice from their senior examiner if in any doubt.

M	mark is for method
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
ft	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
PI	possibly implied
SCA	substantially correct approach
c	candidate
sf	significant figure(s)
dp	decimal place(s)

Q	Answer	Mark	Comments
1(a)	1.23×10^9	B1	

1(a)	Additional Guidance		

1(b)	Label (horizontal) x axis (eg number of users) and/or (vertical) y axis (eg year) or label axis Correctly place the year before the number of users (eg year 2004-2007) Use key to indicate (eg for the 'm' or indicate what 'm' is or use ' '000 000s) or make it clear what 'm' stands for Bar should be drawn in proportion or accept similar explanation or add a scale on the axis Improve title/make it clear what the numbers represent eg what part of the year	E2	E1 for each valid improvement Ignore any additional but incorrect suggestions SC1 (two errors identified but no suggestions for improvement made) oe for all

1(b)	Additional Guidance
	E0 for suggesting other form of graphs eg line graph, vertical bar chart etc

1(c)	It should be 608 not 680, making reference to (680 - 360) He should have stated the number in 'm' or millions (should put 'm' next to his numbers) The denominator should be 6 not 5 or seen in calculation He could use a quicker way to calculate using $\frac{\text{final value} - \text{initial value}}{n}$ or $\frac{1230 - 58}{n}$ He should have stated his answer/the answer is not given	B3	Award B1 for each error or improvement Calculating the mean doesn't score a mark

Q	Answer	Mark	Comments
1(d)	**Alt 1**		
	900 + 40 or 940	M1	
	(40 ÷ 940) × 350	M1	Award M1 for using stratified sampling
	14 or 15	A1	
	Says that the data doesn't support the claim or They should have selected 14 or 15 users not 25 or The number of Instagram users selected in the survey is too large	E1	Dep on second M1
	Alt 2		
	900 + 40 or 940	M1	
	$\frac{25}{350}$ or $\frac{40}{940}$ or 0.07(14…) or 0.04(26…) or 7.(14…) % or 4.(26…)%	M1	Award M1 for using proportionality
	'not equal' or 'not similar' or 'disproportionate' eg: $\frac{25}{350} \neq \frac{40}{940}$ or 0.0714 ≠ 0.0426 or 7.14% ≠ 4.26%	A1	Award A1 for comparing both fractions/decimals/% and concluding that they are not equal/disproportionate ft their '940' ≠ can be implied
	Says that the data doesn't support the claim (must have compared two figures before concluding)	E1	Dep on second M1

Alt 3

	350 – 25 or 325 or 900 + 40 or 940	M1	
	Using ratios $\frac{325}{25}$ or $\frac{900}{40}$ or 13 or 22.5 or $\frac{325}{350}$ or $\frac{900}{940}$ or 0.92(85…) or 0.95(74…)	M1	
	'not equal' or 'not similar' or 'disproportionate' $\frac{325}{25} \neq \frac{900}{40}$ or $13 \neq 22.5$ or $\frac{325}{350} \neq \frac{900}{940}$ or $0.92(85\ldots) \neq 0.95(74\ldots)$	A1	Award A1 for comparing both fractions/decimals/ratios and concluding that they are not equal/disproportionate ft their '940' ≠ can be implied
	Says that the data doesn't support the claim (must have compared two figures before concluding)	E1	Dep on second M1

1(d)	**Additional Guidance**
	For A1, must compare two fractions with same denominator or two decimals or percentages
	Pairs of fractions can be inverted
	Candidates may attempt to work out the actual numbers and compare. Eg $\frac{25}{350}$ x 940 or 67.(…) or $\frac{25}{325}$ x 900 or 69.(…) scores M1M1A1 Note: 350 must be paired with 940 or 325 must be paired with 900 to score A1 Incorrect pairing can score M1M1A0E1

Q	Answer	Mark	Comments
1(e)	50 x 61.48 ÷ 1.60 or 2000 x 1.60 ÷ 50 or 2000 x 1.60 ÷ 61.48 or 50 x 61.48 and 2000 x 1.6	M1	
	(£) 1921.(…) or ($) 64 or 52.(…) (shares) or ($) 3074 and ($) 3200 **and statement** No she is wrong/not correct	A1	Allow 1900 or 1920 oe

Q	Answer	Mark	Comments
2(a)(i)	(Figure 1) The shapes are too close to each other or overlap Can't see where anything is in Central Asia You can't work out the values accurately The lines and the shapes don't correspond with the numbers Use of shapes makes readings inaccurate	E1	E1 for one valid reason Ignore any additional but incorrect reason oe for all

Q	Answer	Mark	Comments
2(a)(ii)	(Table 1) Some data were not shown/missing (eg total population/illiterate men) (On the right column) it got mixed with % and numbers	E1	E1 for one valid reason Ignore any additional but incorrect reason

2(a)(ii)	**Additional Guidance**
	Suggested improvements can imply the errors

Q	Answer	Mark	Comments
2(b)	**Alt 1** **Paul's Statement**		
	0.157 or 15.7%	B1	
	781m ÷ their '0.157' or 4975m (or value rounds to 5billion)	M1	ft their 0.157 for [0.15,0.18]
	their '84.3%' of their '4975m' (or value rounds to 5billion)	M1	their '84.3%' must be 100 – their [15,18]%
	4194m (or value rounds to 4.2 billion) **and** Paul is right/statement is correct	A1	SC2 5billion x 84.3% = 4215m **and** Paul is right SC1 without conclusion
	Alt 2 **Paul's Statement**		
	0.157 or 15.7%	B1	
	4.2billion ÷ their '84.3%' or 4982m (or value rounds to 5billion)	M1	their '84.3%' must be 100 – their '15.7%'
	their 4982m (or value rounds to 5billion) x their '0.157 or 15.7%'	M1	ft their 0.157 for [0.15,0.18]
	782m **and** Paul is right/statement is correct	A1	SC2 5billion x 15.7% = 782m **and** Paul is right SC1 without conclusion
	Rena's statement		
	Cannot use the '20 years/2 decades' alongside the points in the graph/ Graph does not support/Graph cannot be used to check this or Although 20 years cannot be worked out/calculated from the diagram, it is evident that several other regions have made much greater progress from their starting point or Central Asia has made the least progress in terms of raising percentage. or Other regions made greater progress	B1	
	Not possible to check/tell/confirm Rena's statement. or **Rena is wrong**/ Her statement is incorrect.	E1	ft their reasoning
2(b)	**Additional Guidance**		
	There are 4 marks for Paul and 2 marks for Rena		

Q	Answer	Mark	Comments
3	90% value → 1.64(49) seen	B1	1.64(49) can be implied in C.I calculation
	(173 + 186 + 176 + …+ 173) ÷ 10 or 180.5 (cm)	M1	Calculate mean
	their 180.5 ± their '1.64(49)' × √40 ÷ √10 or their 180.5 ± their '1.64(49)' × 2 or their 180.5 ± 3.29 or their 180.5 ± 3.28	M2dep	Dep on using a mean between 178.5 and 182.5 M2 for correct equation using their value of 1.64(49) M1 for one error in the equation
	177.2.....	A1ft	ft their '1.64(49)' awrt 183.8 may imply method mark
	Claim is correct	E1	ft their decision based on their (177.2...)

3	**Additional Guidance**
	If candidates use 10 or 40 instead of √10 or √40 can score B1 M1 M1 A0 E1
	Premature rounding or truncating (eg √40 = 6) leading to an inaccurate answer only gain method marks
	ISW rounding
	Only lower limit needs to be seen for A1 and E1

Q	Answer	Mark	Comments
4(a)	Cars passing the school	B1	
	Between 3 pm and 4 pm	B1	Allow between 'stated' or 'these' times

4(a)	Additional Guidance
	Ignore other statements unless they contradict
	Must be cars only for the first B1

4(b)	10 x 24.1 or 241 or 20 x 23.1 or 462	M1	
	(their 241 + their 462) ÷ (10 + 20) or 703 ÷ 30 or 23.43(…)	M1	
	23.4	A1	

4(b)	Additional Guidance
	For second M1, (their 241 + their 462) ÷ (10 + 20) can be (24.1 + 23.1) ÷ (10 + 20)

Q	Answer	Mark	Comments
4(c)	$F = 114.7 - 0.48C$	B3	Accept 115 or better from 114.7148493 Accept –0.48 or better from –0.4786950941 or B1 for [114.2,115.2] B1[–0.5, –0.45] Allow $y = 114.7 - 0.48x$
	Their correct line drawn	B3ft	ft their equation ± ½ square B1 one correct point calculated or clearly plotted B2 two correct points calculated or clearly plotted
4(c)	**Additional Guidance**		
	For correct regression line, the mean point is (114.3, 60)		

4(d)	120 used	B1	this can be implied at subsequent working
	their '114.7' – their '0.48' × 120 or evidence of reading at 120	M1	allow ± ½ square
	Correct answer for their graph or equation	A1ft	ft their graph or equation of regression line

4(d)	Additional Guidance
	Correct answer for the correct regression line is [57, 58]
	Answer 54 implies 120 and use of graph scores B1M1A0

Q	Answer	Mark	Comments
5	pmcc = [0.81, 0.82] (Maths v Science)	B1	
	pmcc = [0.14, 0.141] (English v Science)	B1	
	Strong correlation between Maths and Science or accept similar explanation	E1	ft their pmcc's Allow use of scatter graphs for this mark
	the teacher should use maths scores to predict Kenny's science score	E1	ft their pmcc's or scatter graphs
	(however) might not be valid because it involves extrapolation	E1	oe

5	**Additional Guidance**
	If no pmcc or scatter graphs, no E marks awarded

Q	Answer	Mark	Comments
6(a)	Mean journey time (Bus B) 23	B1	
	2.4(8…) or 2.49 or 2.5	B1	Standard deviation of journey time (Bus B)
	(Bus A) → 8:56	B1	Average arrival time Bus A
	(Bus B) → 8:58	B1ft	Average arrival time Bus B ft their '8:58' eg 8:35 + their '23'
	In general Charles arrives at work earlier if he takes Bus A (with the leaving times given)	B1ft	ft their mean journey time and standard deviation of journey times for Bus B
	The spread of the times that he arrives at work is less if takes Bus B or In Bus A, Charles generally arrives by 9.04 and in Bus B, he generally arrives by 9.03 or Journey times with bus B are more reliable	B1ft	oe Spread of the times of arrival (allow journey times)

6(a)	Additional Guidance
	For comparison of mean, they must use the times of arrival (which can also include 1 or 2 sd from the starting time eg: 8.30 + 26 + 4 = 9.00am and 8.35 + 23 +2.5 = 9.00 or 9.01) **and** include statement such as 'in general', 'on average', 'not always' etc

Q	Answer		Mark	Comments
6(b)	**BUS A**	**BUS B**		
	25 to 30 minutes or 8.55 to 8.56 and 8.56 to 9.00	20 to 25 minutes or 8.55 to 8.58 and 8.58 to 9.00	B1	Can be implied from subsequent work Eg –0.25 **and** 1 or –1.2(0 …) **and** 0.8(0 …)
	(25 – 26) ÷ 4 or (8.55 – 8.56) ÷ 4 or –0.25	(20 – their '23') ÷ their '2.49' or (8.55 – their '8.58') ÷ their '2.49' or –1.2(0 …)	M1	Can be implied from 0.59871 or 0.88493 ft their '23' and '2.49' from **6(a)** ft their '25' or their '20'
	(30 – 26) ÷ 4 or (9.00 – 8.56) ÷ 4 or 1	(25 – their '23') ÷ their '2.49' or (9.00 – their '8.58') ÷ their '2.49' or 0.8(0 …)	M1	Can be implied from 0.84134 or 0.78814 ft their '23' and '2.49' from **6(a)** ft their '30' or their '25'
	0.84134 or (1 – 0.59871) or 0.40129	0.78814 or (1 – 0.88493) or 0.11507	M1	ft their probabilities using their '–0.25' or '1' or ft their probabilities using their '–1.2'or '0.8'
	P(–0.25 <*Z*< 1) or 0.84134 – 0.40129	P(–1.2<*Z*< 0.8) or 0.78814 – 0.11507	M1	ft their '–0.25' and '1' ft their '–1.2' and '0.8' oe eg shown diagrammatically on labelled standard Normal distribution curve.
	0.440…	0.673…	A2	A1 for one correct
	Correct conclusion for their final probabilities for both bus A and bus B or explanation based on diagrams for both bus A and bus B		E1ft	
	Assumes journey times are Normally distributed		B1	Must be stated explicitly

6(b)	Additional Guidance
	Mixing up journey times and arrival times (eg: 8.55 – 30) can score B1 only
	Solutions based on shaded areas on standard Normal distribution curves can score B1 M1 M1 M1 M0 A0 A0 E1 B1
	Statements based on the 10 times on Bus B where 7 out of the 10 values meant he can get to work between 8.55am and 9.00am can score B1 M0 M0 M0 M0 A0 A0 E1 B0