Level 3 Certificate
MATHEMATICAL STUDIES
1350/2A

Paper 2A Statistical Techniques

Mark scheme

June 2022

Version: 1.1 Final Mark Scheme

226A1350/2A/MS

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 Examiner.

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Q	Answer	Mark	Comments
1 (a)	11 : 5	B1	

Q	Answer	Mark	Comments
1 (b)	**Alternative method 1**		
	10 × 1 and 15 × 2 and 25 × 2 and 20 × 3 and 5 × 3 and 5 × 4 or 10 × 1 and 40 × 2 and 20 × 3 and 5 × 3 and 5 × 4 or 10 and 30 and 50 and 60 and 15 and 20 or 10 and 80 and 60 and 15 and 20	M1	allow one error or omission may be seen beside table
	185 with correct method	A1	may be implied by 185 + their assumed visitor spaces
	185 and no	E1ft	ft their 185 with yes if their total < 185 or no if their total > 185

Q	Answer	Mark	Comments	
1 (b) cont	**Alternative method 2 (interprets as a total of 3 and 4 spaces for all 4-bed and 5-bed properties)**			
	10 × 1 and 15 × 2 and 25 × 2 and 20 × 3 and 3 and 4 or 10 × 1 and 40 × 2 and 20 × 3 and 3 and 4 or 10 and 30 and 50 and 60 and 3 and 4 or 10 and 80 and 60 and 3 and 4	M1	allow one error or omission may be seen beside table	
	157 with correct method	A1		
	157 and yes	E1ft	ft their 157 with yes if their total < 157 or no if their total > 157	
	Additional Guidance			
	10 + 15 + 25 + 20 + 15 + 20 and 105 and yes			M0 A0 E1ft
	185 may be implied, eg 10 + 80 + 60 + 15 + 20 + 40 = 225 (where 40 spaces assumed for visitor parking) and no			M1 A1 E1
	185 and no with no method seen			M0 A0 E0

Q	Answer	Mark	Comments
1 (c)	**Alternative method 1**		
	80 × 23 ÷ 100 or 18(.4) or 19	M1	implied by 9 or 8 for 2-bedroom flat in table with no incorrect working
	9	A1	no incorrect working number of 2-bedroom flats
	31	B1ft	number of 2-bedroom houses ft 40 – their 9 accept decimals
	Alternative method 2		
	80 × ((23 ÷ 100) – (10 ÷ 80)) or 80 × (0.23 – 0.125) or 8.4	M1	implied by 9 or 8 for 2-bedroom flat in table with no incorrect working
	9	A1	no incorrect working number of 2-bedroom flats
	31	B1ft	number of 2-bedroom houses ft 40 – their 9 accept decimals
	Additional Guidance		
	Award M1 for correct percentage calculation, even if 2-bedroom flat value is greater than 9		
	correct values from incorrect method score M0 A0 but can gain B1ft, eg 40 × 23 ÷ 100 or 9.2 and 9 and 31		M0 A0 B1ft
	80 × 23 ÷ 100 or 18.4 and 8 and 32		M1 A0 B1ft

Q	Answer	Mark	Comments
2 (a)	Any two valid improvements eg Spell out Northern Ireland Include 'other fuels'/the missing category in the key Break down renewables/fossil fuels into different types Add a title to the chart Show the amount of electricity generated in GWh, not the percentage Use pattern to better distinguish the fuel types or label the bars with the fuel type or reorder the bars (so that similar shades are not next to each other) Include grid lines Include more increments on the vertical axis Label the axes Make the gaps equal Include values Add another bar for the whole UK/the UK average	E2	E1 for one valid improvement ignore any additional but non-contradictory suggestions SC1 two or more errors identified instead of improvement

Additional Guidance	
One correct error and one improvement	E1 only
Make the y-axis bigger	E0
Make the y-axis more accurate	E0
Larger scale	E0
Use a separate bar chart for each country	E0
Use a different type of chart	E0
Use colour	E0

Q	Answer	Mark	Comments
2 (b)	**Morning Record**		
	Alternative method 1		
	110 221 × 70 ÷ 100 or 77 154.(7) or 77 155	M1	oe
	77 154.(7) or 77 155 and True	A1	
	Alternative method 2		
	78 105 ÷ 70 × 100 or 111 578.(57…) or 111 579	M1	oe
	111 578.(57…) or 111 579 and True	A1	
	Alternative method 3		
	78 105 ÷ 110 221 (× 100) or 70.8(6…) or 70.9 or 0.708(6…) or 0.709	M1	oe accept 71 or 0.71
	70.8(6…) or 70.9 or 0.708(6…) or 0.709 and True	A1	accept 71 or 0.71

Q	Answer	Mark	Comments
2 (b) cont	**Alternative method 4**		
	(110 221 – 78 105) ÷ 110 221 (× 100) or 32 116 ÷ 110 221 (× 100) or 0.29(1…) or 29(.1…)	M1	oe
	0.29(1…) or 29(.1…) and True	A1	

Q	Answer	Mark	Comments
2 (b) cont	**Daily Bulletin Review**		
	Alternative method 1 (comparing proportions of wind to other renewables)		
	78 105 – 33 791 or 129 + 11 228 + 32 957 or 44 314	M1	
	33 791 ÷ their 44 314 or 0.76(…) and 13 ÷ 17 or 0.76(…)	M1	
	0.76(…) with full method seen and True	A1	oe percentage
	Alternative method 2 (comparing multiplier from wind to other renewables)		
	78 105 – 33 791 or 129 + 11 228 + 32 957 or 44 314	M1	
	their 44 314 ÷ 33 791 = 1.3(1…) and 17 ÷ 13 = 1.3(07…) or 17 ÷ 13 = 1.31	M1	correct for their 44 314
	1.3(…) with full method seen and True	A1	oe percentage

Q	Answer	Mark	Comments
2 (b) cont	**Alternative method 3 (what other renewables should be in 13 : 17)**		
	78 105 – 33 791 or 129 + 11 228 + 32 957 or 44 314	M1	
	33 791 ÷ 13 × 17 or 44 188.(…)	M1	
	44 188.(…) and 44 314 and True	A1	
	Alternative method 4 (comparing one part of wind with one part of other renewables)		
	78 105 – 33 791 or 129 + 11 228 + 32 957 or 44 314	M1	
	33 791 ÷ 13 and their 44 314 ÷ 17	M1	oe eg 33 791 ÷ 13 or 2599 and 44 314 ÷ 2599 or 17.05
	2599.(3…) and 2606.(7…) or 2607 and True	A1	allow 2600

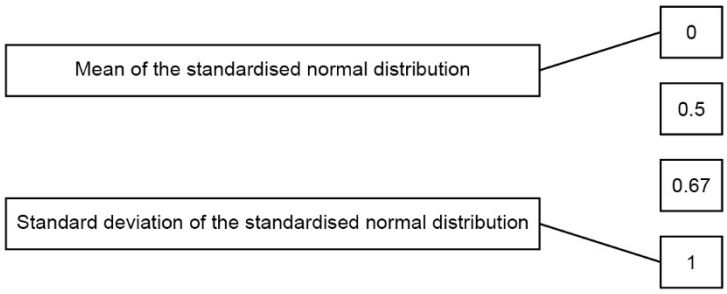
Q	Answer	Mark	Comments
2 (b) cont	**Alternative method 5 (finding an approximately equivalent ratio)**		
	78 105 – 33 791 or 129 + 11 228 + 32 957 or 44 314	M1	
	33 791 ÷ [2533, 2685] and 44 314 ÷ [2533, 2685]	M1	both divisiors must be the same
	33 791 ÷ [2533, 2685] and 44 314 ÷ [2533, 2685] and correct results for their divisor and True	A1	results may be rounded to 13 and 17 with divisor shown
	Alternative method 6 (working out other renewables as 17 parts of total)		
	78 105 – 33 791 or 129 + 11 228 + 32 957 or 44 314	M1	
	78 105 ÷ 30 × 17 or 44 259(.5) or 44 260	M1	
	44 259(.5) or 44 260 and 44 314 and True	A1	

Q	Answer	Mark	Comments	
2 (b) cont	**Alternative method 7 (working out wind as 13 parts of total)**			
	78 105 ÷ 30 or 2603.5 or 2604	M1		
	their 2603.5 × 13 or 33 845(.5) or 33 846	M1		
	33 845(.5) or 33 846 and True	A1		
	Alternative method 8 (comparing wind as a proportion of total renewables)			
	13 ÷ 30 or 0.43(3…)	M1		
	33 791 ÷ 78 105 or 0.43(2…)	M1		
	0.43 with full method seen and True	A1	oe percentage	
	Additional Guidance			
	Variations which mix alternative methods are acceptable. Choose the scheme that favours the student.			
	Accept Yes for True			
	33 791 : 44 314 and 13 : 17.04(8…) and True			M1 M1 A1
	33 791 : 44 314 and 13 : 17.05 and True			M1 M1 A1
	33 791 : 44 314 and 12.96(3…) : 17 and True			M1 M1 A1
	33 791 : 44 314 and 13 : 17 and True with no divisor shown			M1 M0 A0

Q	Answer	Mark	Comments
2 (c)	**Alternative method 1 (first finding GWh used)**		
	4189 × 1 000 000 or 4 189 000 000	M1	oe
	their 4 189 000 000 × 14.4 ÷ 100 or 603 216 000	M1	oe
	603 216 000 or 603 000 000 and Yes	A1	oe
	Alternative method 2 (first finding price per GWh)		
	14.4 × 1 000 000 or 14 400 000	M1	oe
	their 14 400 000 × 4189 ÷ 100 or 603 216 000	M1	oe
	603 216 000 or 603 000 000 and Yes	A1	oe
	Additional Guidance		
	Accept all values in standard form		
	Accept comparison in pence with 60 000 000 000 seen		
	Condone recovery to pounds after working in pence with division by 100 not seen		

Q	Answer	Mark	Comments
2 (d)	**Alternative method 1**		
	7700 ÷ 26.9 or 286.2(4…) or 286.25 or 7700 ÷ 0.269	M1	oe
	[28 490, 28 644]	A1	
	Alternative method 2		
	7700 × 73.1 ÷ 26.9 or 20 924.(5…) or 20 925	M1	oe
	[28 490, 28 644]	A1	
	Additional Guidance		
	Ignore further rounding after answer in interval seen		

Q	Answer	Mark	Comments
2 (e)	Any valid reason eg The amount of electricity produced by each nation is not the same England produces more electricity than Scotland He should have worked out a weighted mean He should have worked out the total energy generated by renewables as a percentage of the overall total He should have used actual values (rather than percentages) You can't always just average percentages Each percentage is the percentage of its own country, not the UK as a whole He has calculated the mean percentage based on each country's total, not the UK as a whole	E1	oe condone the sizes of the nations are not the same

Q	Answer	Mark	Comments
3		B2	B1 for mean or standard deviation correctly matched

Q	Answer	Mark	Comments
4(a)	1.64	B1	

Q	Answer	Mark	Comments
4(b)	103 $\pm$ their 1.64 $\times$ $\sqrt{340} \div \sqrt{20}$ or 103 $\pm$ their 1.64 $\times$ 4.12(…) or 103 $\pm$ 6.76	M2	oe ft their answer to part **4(a)** M1 for one error in the equation accept 1.6449 or 1.645 or 1.65 for 1.64
	([96, 96.5], [109.5, 110])	A1ft	ft their answer to part **4(a)** condone reverse order: [109.5, 110], [96, 96.5])
	Additional Guidance		
	If candidates do not use the correct value of 1.64 or their answer to part **4(a)** they can score maximum M1 eg 103 $\pm$ 1.96 $\times$ $\sqrt{340} \div \sqrt{20}$ (Use of 1.96 counts as one error)		
	If they do not select any answer for part **4(a)** and go on to use 0.90, 1.28 or 2.58 they can score maximum M1 as above		
	If candidates use 340 or 20 instead of $\sqrt{340}$ or $\sqrt{20}$ can score M1 A0 only However, if both 340 and 20 used instead of $\sqrt{340}$ and $\sqrt{20}$ scores 0		
	Not using $\pm$ counts as one error		
	Premature rounding or truncating (eg $\sqrt{20} = 4$) leading to an inaccurate answer can only gain method marks		
	ISW rounding		
	For $z = 1.28$ or 1.2816, CI = ([97.5, 98], [108, 108.5]) For $z = 2.58$ or 2.5758, CI = ([92, 92.5], [113.5, 114]) For $z = 0.9$, CI = ([99, 99.5], [106.5, 107])		
	Correct answer seen without method or contradiction scores full marks		

Q	Answer	Mark	Comments
4(c)	120 does not lie within the confidence interval Or correctly compares 120 with upper limit of their confidence interval	M1	ft their answer to part **4(b)** condone "it" or "the mean" in place of 120
	No or invalid or reject claim	A1ft	oe ft their answer to part **4(b)**
	Additional Guidance		
	Accept equivalents for 'no'		
	If they didn't write a confidence interval in part **4(b),** then part 4**(c)** scores 0		
	If their confidence interval in part **4(b)** does contain 120: M1 for stating 120 does lie within the confidence interval, or for correctly comparing 120 with both their upper and lower limits A1 f.t. for Yes or valid or accept claim oe or insufficient evidence to comment		
	If their confidence interval in part **4(b)** is wholly above 120: M1 for stating 120 does not lie within the confidence interval, or for correctly comparing 120 with lower limit of their confidence interval A1 f.t. for No or invalid or reject claim oe		
	Comparison of 120 with the sample mean (or the midpoint of their confidence interval) scores M0		
	For A1, condone definitive statements such as "the mean IQ cannot be 120" or "the manager's claim is impossible"		
	ISW after a correct answer if candidate makes further spurious or incorrect comments		

Q	Answer	Mark	Comments
5(a)	98 → 1 147 → 5 6 → 3	B2	B1 for one correct

Q	Answer	Mark	Comments
5(b)	Carly **and** large(st) sample	E1	oe accept 3.8 or 25 in place of Carly provided no contradiction seen

Q	Answer	Mark	Comments
5(c)	10 × 3.6 or 36 or 10 × 4.3 or 43 or 25 × 3.8 or 95	M1	may be seen embedded in a calculation or expression
	10 × 3.6 + 10 × 4.3 + 25 × 3.8 + their three scores from part **5(a)** or 174 + their three scores from part **5(a)** or 10 × 3.6 + 10 × 4.3 + 25 × 3.8 + 3 × mean of their three scores from part **5(a)** or 183	M1dep	oe
	their 183 ÷ (3 + 10 + 10 + 25) or their 183 ÷ 48	M1dep	oe dependent on both previous M marks
	3.81(25)	A1ft	ft from their dice scores from part **5(a)** with answer correct to 3 s.f. or better must have scored all 3 method marks **SC2** for final answer of 3.86(…) or 3.87 **SC2** for using just Carly plus their three values from part **5(a)** (3.71… if **5(a)** is correct)
	Additional Guidance		
	First SC2 is for omission of their values from part **5(a)** ie (36 + 43 + 95) ÷ (10 + 10 + 25)		
	Second SC2 ft their values from part **5(a)**		

Q	Answer	Mark	Comments
5(d)	No or likely to be biased or cannot tell **and** the mean is not 3.5 or yes or possibly fair **and** the mean is close to 3.5	B2ft	oe ft their 3.81(25) from part **5(c)** **B1** for 3.5 with no conclusion or with incorrect conclusion **B1** for Yes or possibly fair because the mean is roughly half-way between 1 and 6 oe **B1** for No or likely to be biased or cannot tell because the mean is not half-way between 1 and 6 oe **B1** for No or likely to be biased or cannot tell **and** the mean is not 3

Q	Answer	Mark	Comments
6(a)	–1	B1	oe

Q	Answer	Mark	Comments
6(b)	(pmcc =) 0.44(0…) or 0.441 Positive and weak	B2	B1 for (pmcc =) 0.44(0…) or 0.441 condone “moderate” in place of “weak” accept “fairly weak” oe do not accept “very weak”, “extremely weak” oe
	Additional Guidance		
	Commenting on the type / strength of the correlation without calculating a value for the pmcc scores B0		

Q	Answer	Mark	Comments
7(a)	$(X \sim)$ N(1.58 , 0.31^2) or $(X \sim)$ N(1.58 , 0.0961)	B1	condone missing X or other letters (except N) in place of X
	Additional Guidance		
	Accept Normal for N providing there are no other words Accept n for N		
	Normal and 1.58 and 0.31^2 scores B1		
	N ~ X (1.58 , 0.31^2) scores B0		

Q	Answer	Mark	Comments
7(b)	$(z =)$ (2 – 1.58) ÷ 0.31 or [1.35, 1.36]	M1	condone (1.58 – 2) or [–1.36, –1.35] may be implied by final answer of [0.0869, 0.09]
	[0.91, 0.9131]	A1	oe allow recovery

Q	Answer	Mark	Comments
7(c)	$(z =)$ (1.3 – 1.58) ÷ 0.31 or –0.9(0…)	M1	condone (1.58 – 1.3) or 0.9(0…) may be implied by final answer of [0.8, 0.82]
	[0.18, 0.2]	A1	oe allow recovery

Q	Answer	Mark	Comments
7(d)	$\frac{k-1.58}{0.31} = [-0.254, -0.25]$ or $\frac{1.58-k}{0.31} = [0.25, 0.254]$	M2	M1 for either side of the equation correct. M1 implied by final answer of [1.65, 1.66] with no incorrect working seen
	[1.5, 1.51]	A1	allow recovery
	Additional Guidance		
	M1 can be awarded for $\frac{k-1.58}{0.31}$ or $\frac{1.58-k}{0.31}$ or [–0.254, –0.25] or [0.25, 0.254], even if not seen as part of an equation.		
	[1.65, 1.66] comes from $\frac{k-1.58}{0.31} = [0.25, 0.254]$		

Q	Answer	Mark	Comments
8(a)	E or (34, 74)	E1	

Q	Answer	Mark	Comments
8(b)	$y = 0.63(\ldots)x + 19$	B2ft	B1 for $y = 0.63(\ldots)x + c$ or $y = kx + 19$ ft their outlier values correct to 2 s.f. or better
	Additional Guidance		
	$y = 0.499x + 29.4$ comes from using all the data including the outlier. This scores B0		

Q	Answer	Mark	Comments
8(c)	(test 2 for student H =) [36, 36.1]	B1ft	ft their equation of the regression line. value rounded to nearest integer or better
	their $0.63x$ + their 19 = 49 or (49 – their 19) ÷ their 0.63	M1	oe. May be implied by answer consistent with their regression equation
	(test 1 for student L =) [47, 48]	A1ft	ft their equation of the regression line. value rounded to nearest integer or better

Q	Answer	Mark	Comments
8(d)	**Alternative method 1**		
	$(t =)$ 61, 162, 93, 151, 108, 107, 138, 63, 59, 78, 127, 97	B1ft	ft their H and L at least 8 correct values seen
	(sum of their values of t) ÷ 12	M1	oe. May be implied by correct value for m
	$(m =)$ [103.58, 104]	A1ft	ft their H and L. value rounded to nearest integer or better
	their [103.58, 104] × 0.8 or [82.86, 83.2] **or** their [103.58, 104] × 1.1 or [113.9, 114.4]	M1	either of these two calculations / values seen anywhere in working
	[82.86, 83.2] **and** [113.9, 114.4] clearly selected / used as their bounds	A1ft	ft their m value. Dependent on second M mark only. values rounded to nearest integer or better
	C, E, F and L	A1ft	dependent on both previous M marks. ft their m value and their H and L provided at least two students fall within their bounds
	Alternative method 2 (scaling to use average mark over the two papers)		
	(average mark over the two papers =) 30.5, 81, 46.5, 75.5, 54, 53.5, 69, 31.5, 29.5, 39, 63.5, 48.5	B1ft	ft their H and L at least 8 correct values seen
	(sum of their average marks) ÷ 12	M1	oe. May be implied by correct value for the mean of their average marks
	(mean of their average marks =) [51.79, 52]	A1ft	ft their H and L. value rounded to nearest integer or better
	their [51.79, 52] × 0.8 or [41.43, 41.6] **or** their [51.79, 52] × 1.1 or [56.9, 57.2]	M1	either of these two calculations / values seen anywhere in working

	[41.43, 41.6] **and** [51.79, 52] clearly selected / used as their bounds	A1ft	ft their mean value. Dependent on second M mark only. values rounded to nearest integer or better
	C, E, F and L	A1ft	dependent on both previous M marks. ft their mean value and their H and L provided at least two students fall within their bounds
	Alternative method 3 (scaling each student's total and comparing against 0.8 and 1.1)		
	$(t =)$ 61, 162, 93, 151, 108, 107, 138, 63, 59, 78, 127, 97	B1ft	ft their H and L at least 8 correct values seen
	(sum of their values of t) ÷ 12	M1	oe. May be implied by correct value for m
	$(m =)$ [103.58, 104]	A1ft	ft their H and L. value rounded to nearest integer or better
	Divides at least two of their t values by their m value	M1	
	Correctly divides all 12 of their t values by their m value	A1ft	ft their m value and their H and L all 12 values seen, correct to 2 d.p. or better
	C, E, F and L	A1ft	dependent on both previous M marks. ft their m value and their H and L provided at least two students fall within 0.8 and 1.1