Level 3 Certificate

MATHEMATICAL STUDIES

1350/1

Paper 1

Mark scheme

June 2019

Version: 1.0 Final

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.

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Q	Answer	Mark	Comments
1(a)	primary and qualitative circled	B2	B1 for just one circled and correct or B1 for primary and quantitative circled or B1 for secondary and qualitative circled
	Additional Guidance		
	If more than 2 words are circled		B0

Q	Answer	Mark	Comments
1(b)	Because every car/sample does not have the same chance of being selected or the starting point is not random	B1	oe

Additional Guidance	
Because it's a systematic sample	B0
Comments just relating to one place, one time etc score zero	
Take reference to a single car as being the first car Award B1 for a statement stating that each car does not have an equal chance of being chosen, even if this is with other statements See examples below	
Because its selecting which car to record, its not based on chance (refers to a single car)	B1
Because each car does not have an equal chance of being chose, its only every 20th car that passes by (awarded for first part of statement)	B1
She chose where to start and there is a pattern for the selection of cars (awarded for first part of statement	B1
If it was random every car would have the same chance of being picked (and they don't)	B1
Because she is choosing the 20th car and has therefore selected her own data (No reference to first car)	B0
Because every 20th is a systematic sample	B0
Only the 20th, 40th 60th etc car is selected	B0

Q	Answer	Mark	Comments
2(a)	=C3*1.05	B1	

Q	Answer	Mark	Comments
2(b)	All three correct values completed 2020 April 20 646.74 2021 Jan 21 679.07 or 21 679.08 2021 April 22 112.65 or 22 112.66	B2	B1 for one correct ft their values

Additional Guidance

Mark table unless blank then mark working lines

If their April 2020 is incorrect then for correct ft their Jan 2021 should be their April 2020 value ×1.05 and their April 2021 value should be their Jan 2021 value × 1.02

Example 1

2020 April 21254 (multiplied Jan 2020 by 1.05 instead of 1.02)

2021 Jan 22 316.69 or 22316.70

2021 April 22 763.03

This scores B1 (1st value incorrect 2nd and 3rd correct ft)

Note

using 1.05 and 1.02 in the wrong order gives the following results

Example 2

2020 April 21254

2021 Jan 21679.07

2021 April 22763.03

This scores B1 for the 2nd value correct

Q	Answer	Mark	Comments
2(c)	January 2021	B1ft	ft their first month (and year) where the salary is greater than 21 000

Additional Guidance

Q	Answer	Mark	Comments
2(d)	**Alternative method 1**		
	their 21 679.08 – 21 000 or 679.08	M1	ft their value for the month chosen in 2c
	their 679.08 × 0.09 or 61.11(…) or 61.12 or their 679.08 ÷ 12 or 56.58(…) or 56.59	M1dep	
	their 61.11(…) ÷ 12 or their 56.58(…) × 0.09	M1dep	dep on 1st M1
	5.09	A1ft	ft their value for the month chosen in 2c
	Alternative method 2		
	their 21 679.08 ÷ 12 or 1806.59 **and** 21 000 ÷ 12 or 1750	M1	ft their value for the month chosen in 2c

	their 1806.59 – their 1750 or 56.59	their 1806.59 × 0.09 **and** their 1750 × 0.09 or 162.59(..) **and** 157.5	M1dep	
	their 56.59 × 0.09	their 162.59(..) – their 157.5	M1dep	dep on first M1
	5.09		A1	

Additional Guidance	
For Example 2 in part 2a (using 1.05 and 1.02 in the wrong order) will give this ft answer if April 2020 is chosen in part c 21254 – 21000 or 254 M1 254 × 0.09 or 22.86 M1 22.86 ÷ 12 M1 1.91 or 1.90 A1ft	

Q	Answer	Mark	Comments
3(a)	Lowest 20 and Highest 120	B1	
	LQ 41	B1	
	Median 59	B1	
	UQ 68	B1	
	Additional Guidance		
	The correct values in order of the table are 20 41 59 68 120 (gains B4)		
	Mark the table unless blank. To award credit in working lines the values must be clearly indicated as to what they represent		

Q	Answer	Mark	Comments
3(b)	Correct box and whisker diagrams drawn for both sets of data	B2	ft their values for 1970 to 2000 $\pm\frac{1}{2}$ square B1 one correct box and whisker plot drawn
	Box and whisker plots labelled correctly	B1	1970 and 2010 are sufficient for labels accept letters eg A and B if table is also labelled
	Additional Guidance		
	If both box plots are drawn correctly but the labels are swapped award B2 B0		
	Any height can be used		
	Whiskers do not need end lines		

Q	Answer	Mark	Comments
3(c)	Median is greater for 1970 to 2000 showing that on average the song intros were longer or on average the intros were longer in 1970 or 1970/2000 mean is 58 and 2010 mean is 16.3(…) and so on average the intros were longer in 1970/shorter in 2010 or All 5 values are higher for 1970 to 2000 so the intros are longer	B1ft	oe comment must be in context ft their median for 1970 to 2000 if comparing means, both must be stated and correct
	Comment on the spread of data The IQR/range for 2010 to 2018 is smaller showing more consistency/less variation or the values are more spread out in 1970-2000 or 1970/2000 sd = 22.3 and 2010/2018 sd = 5.5 and the 1970 values were more varied/ the 20101 values were less varied	B1ft	oe comment must be in context ft their IQR/width of box for 1970 to 2000 if standard deviation is used to compare, both values must be stated and correct

Additional Guidance	
Statements about median and IQR with no context gain B0	
The median is higher for 1970-2000	B0
The interquartile range is lower for 2010-2018	B0

Q	Answer	Mark	Comments
4	1.055 or 1 + 0.055 seen	B1	
	Investment ×1.055^{18} ≥ 20 000 or (Investment ≥) 20 000/1.055^{18}	M1	accept = instead of ≥ any letter can be used to represent the investment
	7629.32	A1	accept 7629.40, 7629.50 or 7630 if 7629.32 is seen or B1M1 is awarded 7629.31(8…) is B1M1A0

Additional Guidance	
T&I methods can score full marks for 7629.32 or 1 mark for 1.055 seen There is no method mark for trials	
7630 with no working	zero
The correct answer can be obtained using logarithms even though this is not on paper 1 spec.	

Q	Answer	Mark	Comments
5	Makes an assumption about the amount of time needed to get ready	B1	10 mins to 1 hr 30 min. This may be split into two or more actions eg shower, dress, breakfast travel time to school must not be included allow having different times for girls and boys and combining incorrect conversion from minutes to hours scores B0 eg 105 mins = 1.05 hours
	Makes an assumption about the number of students in a year 10 class	B1	10 to 35
	Makes an assumption about the number of days attending school in a year	B1	5 or 6 days a week for 30-42 weeks per year or 150 to 240 days per year
	Accurate answer to their calculation	B1	must state units with no decimal answers units can be minutes, hours, days, weeks, years

Additional Guidance	
Final B1 must be from time to get ready × number of students × number of days	
For the final mark they may use numbers outside the allowed ranges eg using 365 days or using number of students in a whole school	
Three numbers multiplied together with no indication of what they represent is zero marks but allow the number of days to be 365 without explanation if the other two are specified Example 1 15 × 20 × 365=109500 minutes (no other working/assumptions stated) Example 2 Assume 15 students in a class Assume they take 20 minutes to get ready 5 × 20 × 365=109500 minutes	B0B0B0B0 B1 B1 B0 B1

Q	Answer	Mark	Comments

6	**Alternative method 1**		
	digits 245 seen eg 0.0245 0.00245 1.0245 2.45	B1	With no other digits except zeros or 1+ their 245 digits
	$230\,000 \times x^2$ or 241 408.(..)	M1	where $1.024 \leq x < 1.025$
	their 241 408.06 – 230 000	M1dep	
	(£)11 408.(..)	A1	Rounding or truncating their answer is A0 unless awarding the SC SC1 11643.75
	Alternative method 2		
	digits 245 seen	B1	
	$230\,000 \times x$ or 5636	M1	where $0.024 \leq x < 0.025$
	(230 000 + their 5636) × their 0.0245 or 5773.(..)	M1dep	
	(£)11 408.(..)	A1	Rounding or truncating their answer is A0 unless awarding the SC SC1 11643.75
	Additional Guidance		
	digits 245 can be seen as a lower bound together with an upper bound eg 0.0245 to 0.0255 scores B1 for 245 digits seen Extra non zero digits eg 0.2459 is B0 But 1 + their 245 digits eg 1.0245 is B1		
	Use of 2.5% can only score the SC1 for a correct answer		

Q	Answer	Mark	Comments
	Alternative method 1- calculates the tax and NI on the extra £5250		
	(42 500 + 5250) – (34 500 + 11 850) or 47 750 – 46 350 or 1400	M1	works out amount payable at higher tax or NI
	their 1400 × 0.4 or 560	M1	oe their 1400 cannot be 5250 higher rate tax per year
	(5250 – their 1400) × 0.2 or 770	M1	oe **extra** standard rate tax condone 5250 × 0.2 if higher tax not considered
	their 1400 × 0.02 or 28	M1	oe their 1400 cannot be 5250 higher NI
7	(5250 – their 1400) × 0.12 or 462	M1	oe **extra** standard NI condone 5250 × 0.12 if higher NI is not considered
	their 560 + their 770 + their 28 + their 462 or their 1330 + their 490 or 1820	M1	totals all deductions for the extra £5250 must include standard and higher for both tax and NI may be implied by subsequent subtraction from 5250 1820 implies M6
	5250 – their 1820	M1	their 1820 must include at least one amount of tax and one amount of NI
	3430	A1	extra net pay
	3430 ÷ 12 or 270 × 12	M1	

	285.(…) and Yes	A1ft	ft their 3430

	Alternative method 2- calculates total yearly tax and NI on new salary		
	(42 500 + 5250) – (34 500 +11 850) or 47 750 – 46 350 or 1400	M1	works out amount payable at higher tax or NI
	their 1400 × 0.4 or 560	M1	oe higher rate tax per month their 1400 cannot be 47 750 allow 35900 × 0.4 if standard rate tax is not considered
	34 500 × 0.2 or 6900	M1	oe standard rate tax per year allow 35900 × 0.2 if higher tax not considered 7460 total tax implies M3
	[(42 500 + 5250) – 46 350] × 0.02 or their 1400 × 0.02 or 28	M1	oe higher NI per year
7 (cont'd)	(46 350 – 8424) × 0.12 or 4551.12	M1	oe standard NI per year 8424.01 can be used condone 47 750 for 46 350 if higher NI not considered 4579.12 total NI implies 4th and 5th method marks
	their 560 + their 6900 + their 28 + their 4551.12 or their 7460 + their 4579.12 or 12 039.12	M1	totals all deductions must include standard and higher for both tax and NI may be implied by subsequent subtraction from their 47 750 12 039.12 implies M6
	their 47 750 – their 12 039.12	M1	their 47 750 cannot be 42 500 their 12 039.12 must include at least one amount of annual tax and one amount of annual NI
	35 710.(88)	A1	accept 35 711 from correct working
	(their 35 710.88 ÷ 12) – 2690.07 or 2975.(91) – 2690.07 or	M1	oe

	2690.07 + 270 or 2960.07 or (2690.07 + 270) × 12 or 35520.84		
	285.(…) and Yes or 2975.(..) and 2960.(07) and Yes or 35710.(....) and 35520.(…)	A1ft	ft their 35710.(88)

	Alternative method 3-calculates new monthly tax and NI on new salary			
	(42 500 + 5250) – (34 500 +11 850) or 47750 – 46 350 or 1400	M1	works out amount payable at higher tax or NI	
	their 1400 ÷ 12 × 0.4 or 46.67	M1	oe higher rate tax per month their 1400 cannot be 47 750	
	(34 500 ÷ 12) × 0.2 or 575	M1	oe standard rate tax per month 621.67 implies M3 allow 35900 × 0.2 if higher tax not considered	
7 **(cont'd)**	[(47 750 ÷ 12) – 3863] × 0.02 or (their 3979.(..) – 3863) × 0.02 or 2.3(...)	M1	oe higher NI per month	
	(3863 – 702) × 0.12 or 379.32	M1	oe standard NI per month allow 3979 for 3863 if higher NI not considered	
	their 46.67 + their 575 + their 2.3(..) + their 379.32 or their 621.67 + their 381.6(...) or 1003.(...)	M1	totals all deductions must include standard and higher for both tax and NI may be implied by subsequent subtraction from their 3979.17 1003.(..) implies M6	
	their 3979.(…) – their 1003.(…)	M1	their 1003.(..) must include at least one	

			amount of monthly tax and one amount of monthly NI
2975.(86)		A1	accept 2976 from correct working. new net pay per month
their 2975.(86) – 2690.07 or 2690.07 + 270 or 2960.07		M1	
285.(...) and Yes or 2975.(...) and 2960.(.07) and Yes		A1ft	ft their 2975.(86)

	Additional Guidance
	Yes can be implied eg he can afford it eg he has an extra £15
	If they attempt to work out tax or NI for 42 500 first, ignore it If they only use 42 500 then the only mark available is M1 for 2690.07 + 270
7 (cont'd)	Ignoring the higher NI or higher tax can score a maximum 7 marks Example 47 750 – 34 500 – 11 850 = 1400 M1 1400 × 0.4 = 560 M1 34 500 × 0.2 = 6900 M1 (47 750 – 8424) × 0.12 = 4719.12 M0M1 560 + 6900 + 4719.12 = 12 179.12 M0 (no higher NI included) 47 750 – 12 179.12 M1 (at least one lot of tax and one lot of NI included) 35 570.88 A0 (35 570.88 ÷ 12) – 2690.07 M1 274.17 Yes A1ft
	Ignoring higher tax **and** higher NI can score a maximum 5 marks Example 47 750 – 11 850 = 35 900 M0 35 900 × 0.2 = 7180 M0M1 (47 750 – 8424) × 0.12 = 4719.12 M0M1 7180 + 4719.12 = 11 899.12 M0 (no higher NI or tax included) 47 750 – 11 899.12 M1 (at least one lot of tax and one lot of NI included) 35 850.88 A0 (35 850.88 ÷ 12) – 2690.07 M1 297.50 Yes A1ft

Q	Answer	Mark	Comments
8(a)	Fully correct histogram 18-25 height 2.0 25-40 height 2.4 40-50 height 4.8 50-70 height 1.1	B2	B1 at least 2 bars correct or at least 2 correct frequency densities seen
	Additional Guidance		
	Check widths are correct particularly 18-25 class		

Q	Answer	Mark	Comments
8(b)	**Alternative method 1**		
	Finds $\frac{3}{5}$ of the 2nd bar using any linear scale Correct scale gives $\frac{3}{5}$ × 35 or 21 or 105 small squares or 4.2 (sq cm)	M1	scale must start at 0 can be in small squares, square cm, frequency, lines of 5 may be on diagram Correct scale gives $\frac{3}{5}$ × 35 or 21 and implies 3rd M1
	Their frequency for 5 -15 + their $\frac{3}{5}$ of 2nd bar or 40 + 105 or 145 total small squares or 1.6 + 4.2 or 5.8 sq cm	M1	their 5 -15 value must be correct for their consistent scale correct scale gives 8 + 21 and implies M3
	600 ÷ 120 or 5 (small squares = 1) or 120 ÷ 600 or 0.2 or one line of 5 = 1 person or 1 square cm = 5 people or fd scale labelled correctly with 1 cm = 1 unit	M1	identifying correct scale-may be implied by correct scaling up of their total from previous M1 implied by 8 or 21 or 35 for correct bar 145 ÷ 5 or 5.8 × 5 M3
	29	A1	

	Alternative method 2-working from top end		
8(b) cont'd	$\frac{2}{5}$ of 2nd bar + frequencies for bars 3 to 5 using any linear scale	M1	condone one error but $\frac{2}{5}$ must be used scale must start at 0 can be in small squares, square cm, frequency, lines of 5 correct frequencies are 14 + 46 + 28 + 3
	600 ÷ 120 or 5 (small squares = 1) or 120 ÷ 600 or 0.2 or one line of 5 = 1 person or 1 square cm = 5 people or fd scale labelled correctly with 1 cm = 1 unit	M1	
	120 – ($\frac{2}{5}$ × 35 + 46 + 28 + 3)	M1	may be on histogram con must be correct for their consistent scale
	29	A1	

Additional Guidance
Using a frequency density other than 1cm = 1 means that they must then scale up to 120 people to get the correct answer
Example
Frequency density same as part a) 2cm = 1
(10 × 0.4) + (5 × 3.5) + (10 × 2.3) + (10 × 1.4) + (15 × 0.1) = 60 (needed later but no mark awarded here)
3 × 3.5 = 10.5 M1
10 × 0.4 + 10.5 = 14.5 M1
14.5 × 2 M1 (scaling up their 60 to 120)
29 A1
For this example allow rounding of 10.5 to 11 or 14.5 to 14 or 15

Q	Answer	Mark	Comments
8(c)	$\dfrac{36}{120} \times 50$	M1	oe
	15	A1	
	Additional Guidance		
	finding number of females in the sample first is possible example $\dfrac{76}{120} \times 50 = 31.67 = 32$ females in the sample then $\dfrac{36}{76} \times 32 = 15.16$ so 15 females from 40 to 50 class M1A1 Leaving the answer as 15.16 (or similar decimal) will gain M1A0		
	Do not accept misreads eg wrong group		

Q	Answer	Mark	Comments
	Alternative method 1		
	Measures the length of the motorway on the scale drawing. eg 5.5 cm	M1	allow 5 cm to 6.5 cm implied by a correctly scaled distance between any other places
	their scaled length × 36 eg 5.5 × 36 = 198 ≈ 200 miles	M1dep	estimates the length of the motorway. if no scale/cm length shown, length between 180 and 235 miles implies M2 allow rounding of their motorway length
	Assumes the proportion of 3 lanes and 4 lanes eg 60% are 3 lanes, 40% are 4 lanes	B1	50% - 60% must be 3 lane their number of miles can be split eg their length of motorway = 190 miles and so 100 miles 3 lanes and 90 miles 4 lanes
9(a)	Works out total number of 'lane miles' for one or both directions eg based on 200 miles, 120 × 3 (× 2) + 80 × 4 (× 2) = 1360	M1	must have both 3 lane and 4 lane sections miles for each number of lanes must equal their total motorway length
	their total 'lane miles' × 1600 eg 1400 × 1600 or 2 240 000	M1	converts miles to metres may be all 3 lane
	Calculates **area** of all lanes eg their 2 240 000 × 3.65 or 8 176 000 (sq metres)	M1	must use 3.65 – not rounded-but answer may be rounded dimensions must both be in metres may be all 3 lane
	works out **area** of hard shoulder for one or both directions eg (2 ×) their 200 × 1600 × 3.3 or 211 2000	M1	must use width 3.3

	totals their lane area and hard shoulder area for both directions eg their 81 760 000 + their 2 112 000 or 10 288 000	M1	must be in both directions –may have doubled earlier must have both 3 lane and 4 lane sections their areas can be volumes or lengths
	multiplies their area by £15 eg 10 288 000 × 15	M1	must be area
	accurate answer for their values eg £154 320 000 or £154 million	A1ft	can be rounded but must be whole number ft their values if all method marks awarded if any extra costs are added eg wages etc then A0

9(a) cont'd	**Alternative method 2**		
	Measures the length of the motorway on the scale drawing. eg 5.5 cm	M1	allow 5 cm to 6.5 cm
	their scaled length × 36 eg 5.5 × 36 = 198 ≈ 200 miles	M1dep	estimates the length of the motorway. if no scale/cm length shown, length between 180 and 235 miles implies M2 allow rounding of their motorway length
	Assumes the proportion of 3 lanes and 4 lanes eg 60% are 3 lanes, 40% are 4 lanes	B1	50% - 60% must be 3 lane their number of miles can be split eg their length of motorway = 190 miles and so 100 miles 3 lanes and 90 miles 4 lanes implied by using their proportions later
	(3 × 3.65 + 3.3) (× 2) or 14.25 or 28.5 or (4 × 3.65 + 3.3) (× 2) or 17.9 or 35.8	M1	works out total width of motorway for 3 or 4 lanes, including hard shoulder can be one or both directions (multiplication by 2 for both ways may be seen later) totals may be rounded/truncated
	works out length of their 3 lanes in metres	M1	award even if not used

	eg their 120 miles × 1600 or 192 000 or works out length of their 4 lanes in metres eg their 80 × 1600 or 128 000 or works out their length of motorway in metres		their total length can be 36
	works out **area** of their 3 lane section eg their 192 000 × their 28.5 or 547 2000	M1	one or both directions dimensions must be metres
	works out **area** of their 4 lane section eg their 128 000 × their 35.8 or 4 582 400	M1	one or both directions dimensions must be metres
	totals their areas for **both** directions eg their 5 472 000 + their 4 582 400 or 10 054 400	M1	must have 3 lane and 4 lane sections their areas can be volume or lengths
	multiplies their total area by £15 eg their 10 054 400 × 15	M1	must be area
	accurate answer for their values rounded to sensible sf eg £150 816 000 rounded to £151 million	A1ft	can be rounded but must be whole number unless in millions or standard form eg 150.8 million ft their values if all method marks awarded If any extra costs are added eg wages etc then A0

	Alternative method 3 – averages the number of 3 and 4 lanes		
9(a)	Measures the length of the motorway on the scale drawing. eg 5.5 cm	M1	allow 5 cm to 6.5 cm Implied by a correctly scaled distance between any other places
	their scaled length × 36 eg 5.5 × 36 = 198 ≈ 200 miles	M1dep	estimates the length of the motorway. if no scale/cm length shown, length between 180 and 235 miles implies M2 allow rounding of their motorway length

their motorway length × 1600 eg 200 × 1600 = 320 000	M1	converts to metres award even if not used
works out **area** of one lane for whole length of motorway eg their 320 000 × 3.65 or 11 686 000	M1	one or both directions dimensions must be metres must use 3.65 (no rounding)
Assumes the proportion of 3 lanes and 4 lanes is about half uses an average of 3.5 lanes each way (or 7 lanes in total)	B1	
multiplies their **area** of one lane by average number of lanes one or both directions eg 3.5 × 2 × 11 686 000 or 81 760 000	M1	or multiplies their area of one lane by £15 eg 11 686 000 × 15 or 17 520 000 must be area
works out **area** of hard shoulder for one or both directions eg 2 × their 200 × 1600 × 3.3 or 211 2000	M1	must use width 3.3
totals lane area and hard shoulder area for **both** directions eg their 81 760 000 + their 2 112 000 or 10 288 000	M1	multiplies their cost per lane by their average number of lanes (for 3 and 4 lane sections) eg 7 × 17 520 000 or 122 640 000 their areas can be volumes or lengths
multiplies their area by £15 eg 10 288 000 × 15	M1	totals lanes and cost of hard shoulder for both directions eg their 122 640 000 + 15 × their 2 112 000 must be area
accurate answer for their values eg 154 320 000 rounded to 154.3 million	A1ft	can be rounded but must be whole number ft their values if all method marks awarded if any extra costs are added eg wages etc then A0

Additional Guidance	
It is possible to do parts of different alts eg changes their miles for length of motorway to metres and then multiplies by number of lanes	
One way only gains a maximum of 8 marks	

	If there is no 4 lane section a maximum of 6 marks is available If all other work is correct in Alt 2 this would be M1M1B0M1M1M1M0M0M1A0		
	Allow answers in standard form		
	If they use a depth and work out the volume of the motorway instead of the area they will not gain the marks for working out the areas or the accuracy mark but can access all other marks		

9(b)	Acceptable explanation Examples If the number of miles of 4 lanes was more, then my answer would be too small/increase or If the motorway was shorter the cost would be less or if the hard shoulder did not go all the way/ had gaps the cost would be less	B1	must relate to their assumption about the proportion or to their length of motorway and must state **how** it would have affected the answer eg smaller/more etc