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# Level 3 Certificate

# MATHEMATICAL STUDIES

# 1350/2C

Paper 2C Graphical techniques

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Mark scheme

June 2024

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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 Examiner.

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.

No student should be disadvantaged on the basis of their gender identity and/or how they refer to the gender identity of others in their exam responses.

A consistent use of 'they/them' as a singular and pronouns beyond 'she/her' or 'he/him' will be credited in exam responses in line with existing mark scheme criteria.

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

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## Glossary for Mark Schemes

Mathematical Studies examinations are marked in such a way as to award positive achievement wherever possible. Thus, for Mathematical Studies 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.

<b>M</b>	Method marks are awarded for a correct method which could lead to a correct answer.
<b>A</b>	Accuracy marks are awarded when following on from a correct method. It is not necessary to always see the method. This can be implied.
<b>B</b>	Marks awarded independent of method.
<b>ft</b>	Follow through marks. Marks awarded for correct working following a mistake in an earlier step.
<b>SC</b>	Special case. Marks awarded for a common misinterpretation which has some mathematical worth.
<b>M dep</b>	A method mark dependent on a previous method mark being awarded.
<b>B dep</b>	A mark that can only be awarded if a previous independent mark has been awarded.
<b>oe</b>	Or equivalent. Accept answers that are equivalent. eg accept 0.5 as well as $\frac{1}{2}$
<b>[a, b]</b>	Accept values between a and b inclusive.
<b>[a, b)</b>	Accept values $a \leq \text{value} < b$
<b>3.14 ...</b>	Accept answers which begin 3.14 eg 3.14, 3.142, 3.1416
<b>Use of brackets</b>	It is not necessary to see the bracketed work to award the marks.

Examiners should consistently apply the following principles

**Diagrams**

Diagrams that have working on them should be treated like normal responses. If a diagram has been written on but the correct response is within the answer space, the work within the answer space should be marked. Working on diagrams that contradicts work within the answer space is not to be considered as choice but as working, and is not, therefore, penalised.

**Responses which appear to come from incorrect methods**

Whenever there is doubt as to whether a student has used an incorrect method to obtain an answer, as a general principle, the benefit of doubt must be given to the student. In cases where there is no doubt that the answer has come from incorrect working then the student should be penalised.

**Questions which ask students to show working**

Instructions on marking will be given but usually marks are not awarded to students who show no working.

**Questions which do not ask students to show working**

As a general principle, a correct response is awarded full marks.

**Misread or miscopy**

Students often copy values from a question incorrectly. If the examiner thinks that the student has made a genuine misread, then only the accuracy marks (A or B marks), up to a maximum of 2 marks are penalised. The method marks can still be awarded.

**Further work**

Once the correct answer has been seen, further working may be ignored unless it goes on to contradict the correct answer.

**Choice**

When a choice of answers and/or methods is given, mark each attempt. If both methods are valid then M marks can be awarded but any incorrect answer or method would result in marks being lost.

**Work not replaced**

Erased or crossed out work that is still legible should be marked.

**Work replaced**

Erased or crossed out work that has been replaced is not awarded marks.

**Premature approximation**

Rounding off too early can lead to inaccuracy in the final answer. This should be penalised by 1 mark unless instructed otherwise.

**Continental notation**

Accept a comma used instead of a decimal point (for example, in measurements or currency), provided that it is clear to the examiner that the student intended it to be a decimal point.

Q	Answer	Mark	Comments
1 (a)	Nine hundred thousand	B1	

Q	Answer	Mark	Comments
1 (b)	<p>Any two valid improvements eg</p> <p>Include a vertical / y axis or put percentages / values / scale on vertical / y axis</p> <p>Include (horizontal) grid lines or use graph paper</p> <p>Represent streaming services consistently on the two graphs, eg consistently combine Google and YouTube into a single bar</p> <p>Do not show bars that represent 0% or combine services with low proportions into an 'other' bar</p> <p>Move the 'Streaming service' title (to be on the horizontal axis) or move the 'Proportion' title (to the left-hand side)</p> <p>Define 'Daily active users' or 'Weekly active users' more precisely</p> <p>Give units for average age</p> <p>Define average age (to be about the user, not the streaming service)</p> <p>Move 'Average age' so it doesn't look like the graph's title</p> <p>Give all average ages to one decimal place or nearest integer or in years and months</p> <p>Remove the average ages or show on a separate graph</p> <p>Show all percentages outside of the bars</p> <p>Show (small) percentages to one or more decimal places</p> <p>Show (small) percentages more accurately</p>	E2	<p>E1 for one valid improvement ignore any additional but non-contradictory suggestions</p> <p>SC1 two or more valid errors identified instead of improvements</p>

**Additional guidance is on the next page**

		<b>Additional Guidance</b>	
<b>1 (b) cont'd</b>	For E2 do not accept repeated improvements eg include a vertical axis on graph 1 and include a vertical axis on graph 2		E1
	One correct error and one improvement		E1 only
	Add grid lines		E1
	Grid lines		E0
	Include vertical grid lines		E0
	Include horizontal grid lines <b>on graph 2</b>		E0
	Vertical axis		E0
	Label the axes		E0
	Include a horizontal axis		E0
	Include an axis		E0
	Make the y-axis bigger / more accurate / smaller increments		E0
	Larger scale		E0
	Explain what BBC stands for		E0
	Use a different type of chart		E0
	Split graph 2 into two graphs: one for daily active users, another for weekly active users		E0
	Arrange the services in graph 1 in order of average age		E0
	Use colour		E0
	Move the key outside the graph		E0
	Add a bar to graph 1 for average age		E0
Use actual values not percentages		E0	

Q	Answer	Mark	Comments	
1 (c)	Any valid reason eg There is no explanation for 27% There is no label for 27% It is not clear what the 2%+ relates to Some percentages are given as a range It is not clear how the final percentages (eg 16.5%, 6.75% or 3.75%) are calculated The percentages do not add up to 100% 55% is repeated It is not always clear whether the percentages are kept or passed on Some of the terms (eg public performance) are not defined	E1	E1 for one valid reason	
	<b>Additional Guidance</b>			
	Using percentages of percentages is confusing		E1	
	Too much information shown		E0	
	Too many arrows		E0	
	The arrows don't join up		E0	
	Some arrows / percentages not labelled		E0	
	It is not clear who the 3.75% goes to		E0	
	It is not clear what the percentages are allocated to		E0	
	Percentages are unclear		E0	
	Some percentages are in boxes but others are not		E0	
	Some of the terms (eg MCPS) are abbreviated		E0	

Q	Answer	Mark	Comments
1 (d)	<b>Alternative method 1</b>		
	5 ÷ 14 or 0.35(7...) or 0.36 or 20 ÷ 47 or 0.42(5...) or 0.426 or 0.43	M1	oe percentage or fraction
	0.35(7...) or 0.36 <b>and</b> 0.42(5...) or 0.426 or 0.43 <b>and</b> Greater proportion in the sports club (of daily users of BBC Sounds than in the UK as a whole)	A1	oe percentage or fractions with common denominator
	<b>Alternative method 2</b>		
	20 ÷ 5 (× 14) or 4 or 56	M1	
	56 <b>and</b> 47 <b>and</b> Greater proportion in the sports club (of daily users of BBC Sounds than in the UK as a whole)	A1	
	<b>Alternative method 3</b>		
	20 ÷ 5 (× 9) or 4 or 36 or 27 ÷ 4 or 6.75	M1	
	36 or 6.75 <b>and</b> Greater proportion in the sports club (of daily users of BBC Sounds than in the UK as a whole)	A1	oe, eg 5 : 9 = 20 : 36 (and 20 : 27) or 20 : 27 = 5 : 6.75 (and 5 : 9)

The mark scheme for Question 1 (d) continues on the next page

Q	Answer	Mark	Comments
<b>1 (d) cont'd</b>	<b>Alternative method 4</b>		
	27 ÷ 9 (× 5) or 3 or 15 or 20 ÷ 3 or 6.6(...) or 6.7	M1	
	15 or 6.6(...) or 6.7 <b>and</b> Greater proportion in the sports club (of daily users of BBC Sounds than in the UK as a whole)	A1	oe, eg 20 : 27 = 6.7 : 9 (and 5 : 9) eg 5 : 9 = 15 : 27 (and 20 : 27)
	<b>Alternative method 5</b>		
	20 ÷ 5 or 4 or 27 ÷ 9 or 3	M1	
	4 <b>and</b> 3 <b>and</b> Greater proportion in the sports club (of daily users of BBC Sounds than in the UK as a whole)	A1	
	<b>Alternative method 6</b>		
	5 ÷ 9 or 0.55(...) or 0.56 or 20 ÷ 27 or 0.74(...)	M1	
0.55(...) or 0.56 <b>and</b> 0.74(...) <b>and</b> Greater proportion in the sports club (of daily users of BBC Sounds than in the UK as a whole)	A1	oe percentage	

The mark scheme for Question 1 (d) continues on the next page

Q	Answer	Mark	Comments
1 (d) cont'd	<b>Alternative method 7</b>		
	9 ÷ 5 or 1.8 or 27 ÷ 20 or 1.35	M1	oe, eg 80% higher
	1.8 <b>and</b> 1.35 <b>and</b> Greater proportion in the sports club (of daily users of BBC Sounds than in the UK as a whole)		oe, eg 35% higher
	1.8 <b>and</b> 1.35 <b>and</b> Greater proportion in the sports club (of daily users of BBC Sounds than in the UK as a whole)	A1	oe percentage
	<b>Additional Guidance</b>		
	Scaling up or down ratios from either side is acceptable		
	Reciprocal methods are acceptable		
	Greater at the sports club		A1
	More at the sports club		A1
	More listeners in the sports club		A0
More people at the sports club		A0	

Q	Answer	Mark	Comments
<b>1 (e)</b>	<b>The Recorder</b>		
	30% or 30–34% <b>and</b> 27% or 2.50 or 2.496 <b>and</b> 2.24(64) or 2.25 and True	B1	
	<b>Waxing Lyrical</b>		
	<b>Alternative method 1</b>		
	25 ÷ 44 or 0.568(...) or 0.57	M1	oe
	4 ÷ 7 or 0.571(...) or 0.57	M1	oe
	0.568(...) or 0.57 and 0.571(...) or 0.57 and True	A1	oe
	<b>Alternative method 2</b>		
	44 ÷ 25 or 1.76	M1	oe
	7 ÷ 4 or 1.75 or their 1.76 × 4 or 7.04	M1	oe
	1.76 and 1.75 and True or 7.04 and True	A1	oe

The mark scheme for Question 1 (e) continues on the next page

Q	Answer	Mark	Comments
<b>1 (e)</b> <b>cont'd</b>	<b>Alternative method 3</b>		
	44 ÷ 7 or 6.28(57...) or 6.29	M1	oe
	25 ÷ 4 or 6.25	M1	oe
	6.28(57...) or 6.29 and 6.25 and True	A1	oe
	<b>Alternative method 4</b>		
	4 ÷ 25 or 0.16	M1	oe
	their 0.16 × 44 or 7.04	M1	oe
	7.04 and True	A1	oe
	<b>Alternative method 5</b>		
	44 ÷ 7 or 6.28(57...) or 6.29	M1	oe
	their 6.28(57...) × 4 or 25.(14...)	M1	oe
	25.(14...) and True	A1	oe
	<b>Alternative method 6</b>		
	25 ÷ 4 or 6.25	M1	oe
	44 ÷ their 6.25 or 7.04 or 7 × their 6.25 or 43.75	M1	oe
	7.04 or 43.75 and True	A1	oe

The mark scheme for Question 1 (e) continues on the next page

Q	Answer	Mark	Comments
<b>1 (e) cont'd</b>	<b>Alternative method 7</b>		
	7 ÷ 44 or 0.159(...) or 0.16	M1	oe
	their 0.159(...) × 25 or 3.97(...) or 3.98	M1	oe
	3.97(...) or 3.98 and True	A1	oe
	<b>Alternative method 8</b>		
	44 ÷ 100 × 22.6 or 9.9(44) or 25 ÷ 100 × 22.6 or 5.65 or 5.7	M1	oe 22.6 can be any value if used consistently
	their 9.9(44) ÷ 7 or 1.42(...) <b>and</b> their 5.65 ÷ 4 or 1.41(...) or their 5.65 ÷ 4 × 7 or 9.88(75) or 9.89 or 9.9	M1	oe
	1.42(...) and 1.41(...) or 9.9(44) and 9.88(75) or 9.89 or 9.9 and True	A1	oe
	<b>Additional Guidance</b>		
	Accept roughly correct for true		

Q	Answer	Mark	Comments
1 (f)	No or cannot tell and Valid reason eg You cannot add together the daily active user percentages as some consumers may use more than one streaming service We cannot tell because we don't know if daily active users only use one streaming service Graph 1 does not show all streaming services (only leading streaming services)	B1	oe
	<b>Additional Guidance</b>		
	The weekly active users add up to 137% showing that some consumers use more than one platform	B1	
	The weekly active users add up to 137%	B0	
	The percentages add up to 224%	B0	
	The website's claim is correct	B0	

Q	Answer	Mark	Comments
2 (a)	<b>Alternative method 1 (calculating the VAT)</b>		
	9.99 ÷ 1.2 or 8.32(5)	M1	oe accept 8.33 with correct working seen
	9.99 – their 8.32(5) or their 8.32(5) × 0.2 or 1.66(5)	M1dep	9.99 ÷ 6 scores M1 M1 oe accept 1.67 with correct working seen
	1.66(5) and No	A1	accept 1.67 with correct working seen
	<b>Alternative method 2 (showing the stated VAT is 20% of the subscription price)</b>		
	9.99 – 1.67 or 8.32	M1	
	their 8.32 × 0.2 or 1.66(4) or their 8.32 × 1.2 or 9.98(4) or 1.67 ÷ 8.32 = 0.2(0...)	M1dep	oe oe
	1.66(4) and No or 9.98(4) and No or 0.2(0...) and No	A1	
	<b>Alternative method 3 (assuming the VAT is £2 and finding the subscription price)</b>		
	2 ÷ 20 or 0.1	M1	
	their 0.1 × 120 or 12	M1dep	
	12 and No	A1	with M1 M1 scored

The mark scheme for Question 2 (a) continues on the next page

Q	Answer	Mark	Comments
<b>2 (a) cont'd</b>	<b>Alternative method 4 (showing the stated VAT is 20% of the subscription price)</b>		
	1.67 ÷ 0.2 or 8.35 or 9.99 ÷ 1.2 or 8.32(5)	M1	oe  accept 8.33 with correct working seen
	their 8.35 + 1.67 or 10.02 or their 8.32(5) + 1.67 or 9.99(5) or their 8.32(5) + 2 or 10.32(5) or 9.99 – 1.67 or 8.32 or 9.99 – 8.32(5) or 1.66(5)	M1dep	oe  accept 10.00 with correct working seen  accept 10.33 with correct working seen
	10.02 or 9.99(5) or 10.32(5) or 8.32(5) or 1.66(5) <b>and</b> No	A1	accept 10.00 with correct working seen accept 10.33 with correct working seen accept 8.32 or 8.33 with correct working accept 1.66 or 1.67 with correct working

Q	Answer	Mark	Comments	
2 (b)	Two valid mistakes eg 22.6 million is 22 600 000 or 22.6 million is not 226 000 000  16.5% is 0.165 or 16.5% is not 0.0165  The yearly subscription revenue is £8.32 or The yearly subscription revenue is not £9.99 after VAT or Molly should have used the subscription revenue before VAT or Molly did not take into account VAT	E2	E1 for one valid mistake oe ignore any additional but non-contradictory suggestions  accept 226 000 000 is wrong     accept 0.0165 is wrong       do not allow 'she has not included VAT'	
	<b>Additional Guidance</b>			
	Accept values in millions			
	For E2 do not accept repeated mistakes			
	Condone, eg, '226 million is wrong it should be 2 260 000'			
	Condone, eg, '0.0165 is wrong it should be 0.00165'			

Q	Answer	Mark	Comments
3	<p>Any valid comparisons of 2012 to 2022 supported with correct differences or proportions</p> <p>eg</p> <p>Entries for GCSE French <b>decreased</b> by 24 017 or 15.6(...) % or 15.7%</p> <p>and</p> <p>Entries for GCSE Spanish <b>increased</b> by 40 239 or 55.4(...) %</p>	E2	<p>allow rounding to 2sf</p> <p>E1 for any valid comparison of 2012 to 2022 <b>not</b> supported by both correct differences or proportions</p> <p>entries for GCSE French changed from 153 436 to 129 419</p> <p>or</p> <p>entries for GCSE Spanish changed from 72 606 to 112 845</p> <p>or</p> <p>E1 for correct proportion or difference clearly identified with correct subject with no decision or incorrect decision</p> <p>eg</p> <p>entries for GCSE French is/changed by 15.6(...) %</p> <p>entries for GCSE French increased by 15.6(...) %</p>
	<p>Any valid comparison of students that were male supported by correct proportion(s)</p> <p>eg</p> <p>The proportion of students that were male entered for GCSE Spanish and GCSE French are <b>both</b> around 43%</p> <p>or</p> <p>The proportion of students that were male entered for GCSE Spanish was 42.6% which was <b>lower</b> than the 42.8% entered for GCSE French</p> <p>or</p> <p>The proportion of students that were male entered for GCSE Spanish was 42.6% which was <b>similar</b> to the 42.8% entered for GCSE French</p>	E2	<p>oe decimals</p> <p>allow rounding to 2sf</p> <p>E1 for correct proportion without comparison</p> <p>eg</p> <p>42.6% of students entered for GCSE Spanish were male</p> <p>or</p> <p>42.8% of students entered for GCSE French were male</p> <p>E1 for correct comparison using two correct ratios</p> <p>eg</p> <p>The ratio of male to female was 1 : 1.3(47...) for GCSE Spanish and 1 : 1.3(37...) for GCSE French meaning the proportion of males entering GCSE Spanish was lower/similar than for GCSE French</p>

Q	Answer	Mark	Comments
4 (a)	0, 3.2, 4.5, 6	B1	
	Their points plotted correctly	B1ft	± half grid square
	Their points joined with a smooth curve	B1ft	condone an attempt from a curve accurately plotted from their (incorrect) values. This may be fluctuating curve.

Q	Answer	Mark	Comments
4 (b) (i)	Intersection line seen at $s = 47$ or $s = 55$ or Substitution of $s = 47$ or $s = 55$ into equation	M1	
	[4,4.2] and [5.1,5.3]	A2ft	A1 [4,4.2] or [5.1,5.3] ft their graph without contradiction of an invalid substitution without contradiction of their intersection lines
	<b>Additional Guidance</b>		
	$s = 47$ leads to 4.089 $s = 55$ leads to 5.225		

Q	Answer	Mark	Comments
4 (b) (ii)	Gradient	B1	condone any implied reference to steepness.
	<b>Additional Guidance</b>		
	Graph steeper (in storm)		B1
	Graph less steep (in strong gale)		B1
	Quadratic so gets steeper		B1
	Exponential so gets steeper		B1
	Graph goes up more (in storm)		B0
	Graph goes up less (in strong gale)		B0
	Quadratic		B0
Exponential		B0	

Q	Answer	Mark	Comments
4 (c)	Correct statement eg wind speed will reach a limit wave height will reach a limit may not be true for all oceans or different parts of ocean (ie coast) wave height is subject to high variance height may be affected by other factors	B1	no need to quantify condone colloquial language that carries same meaning.
	<b>Additional Guidance</b>		
	Quantitative examples that show large $s$ give unrealistic $h$ must come with supporting comment.		
	do not know if the trend continues		B0
Do not know where $h$ is measured from or hard to measure $h$		B0	

Q	Answer	Mark	Comments
5 (a)	B	B1	

Q	Answer	Mark	Comments
5 (b)	48 – 12 or 36 or 12 – 48 or – 36	M1	
	Team A = [0.65,0.67]	A1	
	Team B = [0.33,0.35]	A1	SC2 Team A = [0.33,0.35] and Team B = [0.65,0.67]
	<b>Additional Guidance</b>		
	SC2 is for both values correct but designated to the wrong team		

Q	Answer	Mark	Comments
5 (c)	<b>Alternative method 1 – calculating gradient first</b>		
	Difference in $G$ seen from valid gradient triangle or Difference in $E$ seen from valid gradient triangle or Any fraction equivalent to $\frac{80}{1}$	M1	ignore whether values stated are positive or negative
	Substitutes their gradient <b>and</b> any valid coordinate into $G = mE + c$	M1	
	$m = -80$ and $c = 100$	A1	
	<b>Alternative method 2</b>		
	$c = 100$	M1	
	Difference in $G$ seen from valid gradient triangle or Difference in $E$ seen from valid gradient triangle or Any fraction equivalent to $\frac{80}{1}$	M1	ignore whether values stated are positive or negative
	$m = -80$ and $c = 100$	A1	
	<b>Alternative method 3</b>		
	$c = 100$	M1	
	Substitutes any valid coordinate into $G = mE + c$	M1	may be seen with $c = 100$
	$m = -80$ and $c = 100$	A1	

The mark scheme for Question 5 (c) continues on the next page

<b>Alternative method 4 – simultaneous equations</b>			
<b>5 (c) cont'd</b>	Substitutes in any two valid pairs of coordinates and Correct method to eliminate one variable or $m = -80$ or $c = 100$	M1	may be elimination or substitution.
	Substitutes their value of $m$ or $c$ into one of their equations	M1	
	$m = -80$ and $c = 100$	A1	

Q	Answer	Mark	Comments
6 (a)	$y = 7.5$	B1	
	$e^{7.5}$ or 1808.(04...)	M1	ft their y
	1800	A1ft	ft their y
	<b>Additional Guidance</b>		
	$e^7$ leads to 1096.6(3...)		B0 M1 A0
	$e^7$ leading to 1100		B0 M1 A1
	$e^{7.58(3...)}$ leading to 1965.1(6...)		B0 M1 A0
	$e^{7.58(3...)}$ leading to 2000		B0 M1 A1

Q	Answer	Mark	Comments
6(b)	It is the same value (as their answer)	B1	
	<b>Additional Guidance</b>		
	Their answer to <b>question 6(a)</b> with no explanation		B0

Q	Answer	Mark	Comments
7 (a)	500 (s) or 8.3(3..) minutes	M1	if 500 identified as the <b>only</b> time value ignore subsequent incorrect calculations
	8 minutes 20 seconds	A1	

Q	Answer	Mark	Comments
7 (b)	150	B1	

Q	Answer	Mark	Comments	
7 (c)	Tangent drawn from $t = 400$	M1	must not cross the curve (not visibly above curve in the time domain [200,500])	
	Calculate a difference in time or Calculate a difference in velocity	M1dep	must be from their valid tangent	
	[14.5 , 21]	A1		
	$\text{ms}^{-2}$	B1	oe condone m/s/s or $\text{ms}^{-1}\text{s}^{-1}$ or worded	
	<b>Additional Guidance</b>			
	5000 $\div$ 400 (=12.5) seen without valid tangent			M0 M0 M0 A0
	2200 $\div$ 100 (=22) seen without valid tangent			M0 M0 M0 A0

Q	Answer	Mark	Comments
7 (d)	<b>Alternative method 1</b>		
	[7200,7350] ( $\text{ms}^{-1}$ )	B1	
	48 350 $\times$ 1000 or 48 350 000 (m)	M1	oe conversion to metres seen at any stage
	Their 48 350 000 $\div$ their [7200,7350] or [6578, 6715.3] (s)	M1	
	Their [6578, 6715.3] $\div$ 60	M1	oe conversion to minutes seen at any stage
	[109.6,112]	A1	
	<b>Alternative method 2</b>		
	[7200,7350] ( $\text{ms}^{-1}$ )	B1	
	Their [7200,7350] $\div$ 1000 or 1 [7.2, 7.35] ( $\text{kms}^{-1}$ )	M1	oe conversion to $\text{kms}^{-1}$ seen at any stage
	48350 $\div$ their [7.2,7.35] or [6578, 6715.3] (s)	M1	
	Their [6578, 6715.3] $\div$ 60	M1	oe conversion to minutes seen at any stage
	[109.6,112]	A1	

Q	Answer	Mark	Comments
8 (a)	Decreases by 2(%) for every degree increase in temperature	E2	oe E1 decreases or decreases by 2(%) or becomes 98% (of the value)

Q	Answer	Mark	Comments
8 (b)	Substitutes $T = 24$ and $L = 100$	M1	may be seen at any point
	$\frac{100}{0.98^{24}}$ or $k = \frac{L}{0.98^T}$	M1	division may be seen with their decimal value of $0.98^{24}$
	[162.3, 162.4]	A1	accept 162 with correct working

Q	Answer	Mark	Comments	
8(c)	Substitutes $L = 75$	M1	may be done at any stage	
	$\ln(75) = \ln(180e^{-0.035T})$ or $\ln\left(\frac{75}{180}\right) = -0.035T$ or $\ln(75) - \ln(180) = -0.035T$ or $\ln(0.416\dots) = -0.035T$	M1	oe condone any equivalent form prior to a substitution of $L = 75$ must use $\ln$ unless a correct answer is derived from other base logarithm.	
	$T = \frac{\ln\left(\frac{75}{180}\right)}{-0.035}$ or $T = \frac{-0.875\dots}{-0.035}$ or $T = \frac{\ln(75) - \ln(180)}{-0.035}$ or $T = \frac{\ln(0.416\dots)}{-0.035}$	M1	oe condone any equivalent form prior to a substitution of $L = 75$	
	25.(013...)	A1		
	<b>Additional Guidance</b>			
	T&I methods leading to 25.(013...)			M1 M1 M1 A1
	Incorrect answer by T&I methods			M0 M0 M0 A0