

GCE

Quantitative Methods (MEI)

Unit **G244**: Introduction to Quantitative Methods (MEI)

Advanced Subsidiary GCE

Mark Scheme for June 2016

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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1. Annotations and abbreviations

Annotation scoris	in	Meaning
✓ and ✕		
BOD		Benefit of doubt
FT		Follow through
ISW		Ignore subsequent working
M0, M1		Method mark awarded 0, 1
A0, A1		Accuracy mark awarded 0, 1
B0, B1		Independent mark awarded 0, 1
SC		Special case
^		Omission sign
MR		Misread
Highlighting		
Other abbreviations mark scheme	in	Meaning
E1		Mark for explaining
U1		Mark for correct units
G1		Mark for a correct feature on a graph
M1 dep*		Method mark dependent on a previous mark, indicated by *
cao		Correct answer only
oe		Or equivalent
rot		Rounded or truncated
soi		Seen or implied
www		Without wrong working

2. Subject-specific Marking Instructions for GCE Mathematics (MEI) Statistics strand

- a Annotations should be used whenever appropriate during your marking.

The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

- b An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

- c The following types of marks are available.

M

A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, eg by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A

Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B

Mark for a correct result or statement independent of Method marks.

E

A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

- d When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep *' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.
- e The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

- f Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise.

Candidates are expected to give numerical answers to an appropriate degree of accuracy. 3 significant figures may often be the norm for this, but this always needs to be considered in the context of the problem in hand. For example, in quoting probabilities from Normal tables, we generally expect *some* evidence of interpolation and so

quotation to 4 decimal places will often be appropriate. But even this does not always apply – quotations of the standard critical points for significance tests such as 1.96, 1.645, 2.576 (maybe even 2.58 – but not 2.57) will commonly suffice, especially if the calculated value of a test statistic is nowhere near any of these values. Sensible discretion *must* be exercised in such cases.

Discretion must also be exercised in the case of small variations in the degree of accuracy to which an answer is given. For example, if 3 significant figures are expected (either because of an explicit instruction or because the general context of a problem demands it) but only 2 are given, loss of an accuracy ("A") mark is likely to be appropriate; but if 4 significant figures are given, this should not normally be penalised. Likewise, answers which are slightly deviant from what is expected in a very minor manner (for example a Normal probability given, after an attempt at interpolation, as 0.6418 whereas 0.6417 was expected) should not be penalised. However, answers which are *grossly* over- or under-specified should normally result in the loss of a mark. This includes cases such as, for example, insistence that the value of a test statistic is (say) 2.128888446667 merely because that is the value that happened to come off the candidate's calculator. Note that this applies to answers that are given as final stages of calculations; intermediate working should usually be carried out, and quoted, to a greater degree of accuracy to avoid the danger of premature approximation.

The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.

g Rules for replaced work

If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

NB Follow these maths-specific instructions rather than those in the assessor handbook.

h Genuine misreading (of numbers or symbols, occasionally even of text) occurs. If this results in the object and/or difficulty of the question being considerably changed, it is likely that all the marks for that question, or section of the question, will be lost. However, misreads are often such that the object and/or difficulty remain substantially unaltered; these cases are considered below.

The simple rule is that *all* method ("M") marks [and of course all independent ("B") marks] remain accessible but at least some accuracy ("A") marks do not. It is difficult to legislate in an overall sense beyond this global statement because misreads, even when the object and/or difficulty remains unchanged, can vary greatly in their effects. For example, a misread of 1.02 as 10.2 (perhaps as a quoted value of a sample mean) may well be catastrophic; whereas a misread of 1.6748 as 1.6746 may have so slight an effect as to be almost unnoticeable in the candidate's work.

A misread should normally attract *some* penalty, though this would often be only 1 mark and should rarely if ever be more than 2. Commonly in sections of questions where there is a numerical answer either at the end of the section or to be obtained and commented on (eg the value of a test statistic), this answer will have an "A" mark that may actually be designated as "cao" [correct answer only]. This should be interpreted *strictly* – if the misread has led to failure to obtain this value, then this "A" mark must be withheld even if all method marks have been earned. It will also often be the case that such a mark is implicitly "cao" even if not explicitly designated as such.

On the other hand, we commonly allow "fresh starts" within a question or part of question. For example, a follow-through of the candidate's value of a test statistic is generally allowed (and often explicitly stated as such within the marking scheme), so that the candidate may exhibit knowledge of how to compare it with a critical value and draw conclusions. Such "fresh starts" are not affected by any earlier misreads.

A misread may be of a symbol rather than a number – for example, an algebraic symbol in a mathematical expression. Such misreads are more likely to bring about a considerable change in the object and/or difficulty of the question; but, if they do not, they should be treated as far as possible in the same way as numerical misreads, *mutatis mutandis*. This also applied to misreads of text, which are fairly rare but can cause major problems in fair marking.

The situation regarding any particular cases that arise while you are marking for which you feel you need detailed guidance should be discussed with your Team Leader.

Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

Question			Answer	Marks	Guidance	AO	Diff
1			Euros received $(£150) \times 1.15 (= €172.50)$	M1	Selects correct exchange rate and multiplies	1	E
			Notes for changing back €90	M1	Spend €172.50 - €81.25 = €91.25 Rounds down to nearest €5 (FT) Allow coins €1.25	2	E
			£ received $(€90 \div 1.25 =) £72$	A1	Selects correct exchange rate and divides to achieve correct answer	2	E
				[3]			

Question			Answer	Marks	Guidance	AO	Diff
2	(A)		In kilometres: $1.5 \times 10^8 + 1.1 \times 10^8 (= 2.6 \times 10^8)$ $150,000,000 + 110,000,000 (= 260,000,000)$ $150 \text{ (million)} + 110 \text{ (million)} (= 260 \text{ (million)})$ In metres: $1.5 \times 10^{11} + 1.1 \times 10^{11} (= 2.6 \times 10^{11})$ $150,000,000,000 + 110,000,000,000 (= 260,000,000,000)$ $150 \text{ (billion)} + 110 \text{ (billion)} (= 260 \text{ (billion)})$	M1	Converts to similar units and adds Allow kilometres or metres	3	E
			To 1 sf 3×10^8 km	A1	cao but ISW any simplification afterwards	1	E
	(B)		In kilometres: $1.5 \times 10^8 - 1.1 \times 10^8 (= 0.4 \times 10^8)$ $150,000,000 - 110,000,000 (= 40,000,000)$ $150 \text{ (million)} - 110 \text{ (million)} (= 40 \text{ (million)})$ In metres: $1.5 \times 10^{11} - 1.1 \times 10^{11} (= 0.4 \times 10^{11})$ $150,000,000,000 - 110,000,000,000 (= 260,000,000,000)$ $150 \text{ (billion)} - 110 \text{ (billion)} (= 40 \text{ (billion)})$	M1	Converts to similar units and subtracts deduct only one mark for both parts if fails to convert units Allow kilometres or metres	1	E
			To 1 sf 4×10^7 km.	A1	cao but ISW any simplification afterwards	1	E
				[4]			

Question			Answer	Marks	Guidance	AO	Diff
3	(i)		Number of roads 26 Number with decrease in average speed 21	M1	May be seen in calculation $\frac{21}{26} \times 100$ Or in words “21 out of 26 (show decrease)” Allow Increase 5 Decrease 21	3	E
			Percentage with decrease 80.8% (3sf)	A1	Exact answer 80.7692307... Accept 81% (2sf) or 80.77% (4sf)	3	E
				[2]			

Question			Answer					Marks	Guidance	AO	Diff
	(ii)		Route	(Dec 2008)	(Dec 2014)	(Change)	% change	E1	Exact answers 21.6666666...% and 12.6582278...% Accept 22% and 13% (2sf) or better e.g. 21.67% and 12.66% (4sf) i.e. do not penalise rounding since intermediate step/justification not explicitly requested in question but necessary for correct conclusion Allow comparison of new and old percentages ($14.6/12 \times 100 = 12(1.66\dots)$ and $(26.7/23.7 \times 100 = 11(2.658227\dots)$. So allow 120 and 110 or better. Allow use of new average speed as base for comparison $2.6/14.6 \times 100 = 17.8080219\dots$ and $3/26.7 \times 100 = 11.235955\dots$. So allow 20 and 10 or better.	3	E
			A1309N	12	14.6	2.6	$\frac{2.6}{12} = 21.7\%$				
			A603W	23.7	26.7	3	$\frac{3}{23.7} = 12.7\%$				
			The A1309N has the larger (percentage) increase (by 9.0 percentage points)					E1	for making comparison FT their percentages, may be stated before calculations	4	E
								[2]			

Question			Answer	Marks	Guidance	AO	Diff
	(iii)		Percentage increases: A (-)12.5%, B 0%, C (+)25%	B1	For all 3 correct and in correct places in table. Allow 13% or -25%.	3	C
			Weighted mean = $\frac{5000 \times (-12.5) + 3000 \times 0 + 2000 \times 25}{5000 + 3000 + 2000}$	M1 M1	for sum of products of each route by number of cars (i.e. numerator) FT percentages from table for dividing by total (= 10 000) ...	1 2	A A
			= -1.25%	A1	... to achieve correct answer as a percentage. Allow correct answer without working as use of calculator likely. cao	2	A
			Special Case: calculates weighted mean for both years and then compares. 2008: $\frac{5000 \times 32 + 3000 \times 25.2 + 2000 \times 24}{10000} = 28.36$ 2014: $\frac{5000 \times 28 + 3000 \times 25.2 + 2000 \times 30}{10000} = 27.56$ % Change = $\frac{27.56 - 28.36}{28.36} = -0.028\ 208\ 744\ 71 = \text{approx } -2.8\%$		SC1 both numerators correct SC2 divides both by 10,000 SC3 correct percentage decrease -2.8(2087447...)%		
				[4]			

Question			Answer	Marks	Guidance	AO	Diff
4	(i)		For example: The sample is very small	B1	1 mark for each sensible statement	3	C
			<p>Data for 3 consecutive years cannot give information about a long term trend</p> <p>The data are the dates of snowdrops being seen; the connection with global warming is no more than a conjecture (may mention invalid assumption of correlation between temperature and flowering implying causation).</p> <p>The dates for 2014 and 2015 are very close together so may not be a significant change (may mention confidence intervals or other environmental factors).</p> <p>Award credit for other sensible comments</p>	B1	Allow “doesn’t necessarily mean global warming is making the flowers bloom” or discussion of possible data collection errors such as the difficulty of observing any flowers in all locations (i.e. proving a negative) or only one flower or references to the article (e.g. natural variation in snowdrop flowering) or weaknesses of secondary data etc.	3	A
				[2]			
	(ii)		Year is the independent variable and Day is the dependent variable.	B1		2	E
				[1]			

Question			Answer	Marks	Guidance	AO	Diff
	(iii)	(A)	False. Fig 4.2 is not symmetrical. (Requires mention of shape of distribution for example skew)	B1	Award credit for other sensible comments Allow “would not fit”	2	E
		(B)	March 12th is day $31+28+12=71$ OR Fig 4.1 shows the latest date was before Day 70.	M1	May include mention of leap year. Allow concept of March 12 th outside range of values or similar. Can infer value of 68 and date of 9 th March 1986 from fig 4.1. Minimum “too late”	4	C
			False	A1		3	E
		(C)	False. Fig 4.1 shows the variability has reduced (since the early 1990s).	B1	Allow “(Earlier) first bloom in late Feb and March (as well)” or “(later) points are closer together”	3	E
				[4]			

Question			Answer	Marks	Guidance	AO	Diff
5	(i)		$(16 \times £75 =) £1200$	B1		1	E
			50% (of the repayments) is interest	B1	Allow 100% of principal amount if made clear. Minimum required is “100% of the loan”	1	E
				[2]			
	(ii)		$\left(I = \frac{PRT}{100} \right) \Rightarrow 600 = \frac{600 \times R \times 1.33}{100}$	M1	For use of simple interest formula with correct values Be careful for use of compound interest formula for 1.25 years leading to (approximately) correct answer.	1	E
			$R = 75$ So the equivalent rate is 75%.	A1	Allow correct answer without working as use of calculator likely.	2	C
				[2]			

Question			Answer	Marks	Guidance	AO	Diff
	(iii)	(A)	(C2) $= B2 * 0.1$	B1	Or equivalent $=B2/10$	5	E
		(B)	(E2) $= B2 + C2 - D2$	B1	Or equivalent $=B2 - (D2 - C2)$ Watch for wrong way round	5	E
		(C)	(B12) $= E11$	B1	Or equivalent $=B11 + C11 - D11$ $=B11 - (D11 - C11)$	5	E
				[3]	Deduct maximum of one mark in part iii for not keeping to common spreadsheet conventions e.g. missing equals or circular reference or \times rather than $*$ Ignore extra brackets, cell references to the cell being filled and prefixes/suffixes where logic of formula is unaffected.		

Question			Answer						Marks	Guidance	AO	Diff
	(iv)								B3			
				A	B	C	D	E				
			1	Month	Debt	Interest	Payment	Balance				
			2	0	£ 600.00	£ 60.00	£ 75.00	£ 585.00				
			3	1	£ 585.00	£ 58.50	£ 0.00	£ 643.50				
			4	2	£ 643.50	£ 64.35	£ 0.00	£ 707.85				
			5	3	£ 707.85	£ 70.79	£ 0.00	£ 778.64			5	E
			6	4	£ 778.64	£ 77.86	£ 75.00	£ 781.50			5	E
			7	5	£ 781.50	£ 78.15	£ 75.00	£ 784.65			5	E
			8	6	£ 784.65	£ 78.46	£ 75.00	£ 788.11				
						
									[3]			
	(v)	(A)	She never does repay it. The loan keeps increasing.						B1	Minimum required “never”. Allow “interest higher than payment” or “only when extra payments made”	4	C
		(B)	Dawn's mother was right.						B1	Minimum required “good”	4	E
									[2]			

Question			Answer	Marks	Guidance	AO	Diff
6	(i)			B1 B1 B1	B1 for each correct answer	3	E
				[3]			
	(ii)	(A)	$\frac{40}{500} = 0.08$	B1	Allow 8%, fraction or decimal equivalent.	2	C
		(B)	$\frac{320}{500} = 0.64$	B1	Allow 64%, fraction or decimal equivalent. SC1 for both numerators correct in a fraction.	2	C
				[2]			

Question			Answer				Marks	Guidance	AO	Diff																
	(iii)		<table><tr><td>Control group</td><td>Disability</td><td>No disability</td><td>Total</td></tr><tr><td>Get parasite</td><td>16</td><td>304</td><td>320</td></tr><tr><td>Do not get parasite</td><td>0</td><td>180</td><td>180</td></tr><tr><td>Total</td><td>16</td><td>484</td><td>500</td></tr></table>				Control group	Disability	No disability	Total	Get parasite	16	304	320	Do not get parasite	0	180	180	Total	16	484	500	B2	-1 per error	2 2	C C
Control group	Disability	No disability	Total																							
Get parasite	16	304	320																							
Do not get parasite	0	180	180																							
Total	16	484	500																							
							[2]																			

Question			Answer	Marks	Guidance	AO	Diff
	(iv)	(A)	$P(\text{Inoculated but suffer disability}) = \frac{4}{500} (= 0.08)$	M1	Selecting right information	4	C
			$P(\text{Not inoculated but suffer disability}) = \frac{16}{500} (= 0.032)$		Same denominator - allow (with=4 without=16 change = 4 – 16 = -12 so % change = -) 12 / 16 (× 100)		
			Reduction from 16 to 4 oe (is 75%).	A1	(Reduction of 75% given).	4	C
		(B)	$P(\text{Inoculated, get parasite and suffer disability}) = \frac{4}{40} = 0.1$	M1	Selecting right information Allow use of equivalent fraction 32/320 or decimals	4	A
			$P(\text{Not inoculated, get parasite and suffer disability}) = \frac{16}{320} = 0.05$		or change = 0.1-0.05 = 0.05 % change = 0.05/0.05×100 Allow (32 – 16 = 16 % change) 16/16 (× 100)		
			0.05 to 0.1 (is a 100% increase.)	A1	(Increase of 100% given). Beware comments about 100% of those with disability had parasite.	4	A
				[4]			

Question			Answer	Marks	Guidance	AO	Diff
7	(i)		(The number of Tom's ancestors is) $2^{(10)}$	M1	Allow Gen0: 1, Gen1: 2, Gen2: 4... (so doubling).	1	C
			$(2^{10} =) 1024$ (so is just over 1000)	A1	Comparison with 1000 may be implied. Allow listing values.	2	C
				[2]			
	(ii)	(A)	$(2000 - 1700 = 300 \text{ years} \div 30 = 10 \text{ generations.})$ So) 1000 (in 1700.) (One thousand)	B1	Allow 1024 or 1×10^3 .	3	E
		(B)	$(2000 - 1400 = 600 \text{ years} \div 30 = 20 = 2 \times 10 \text{ generations.})$ So $1000 \times 1000 = 1\,000\,000$ (in 1400.) (One million)	B1	Allow 1 048 576 for using 1024 or 1×10^6 .	3	C
		(C)	$(2000 - 1100 = 900 \text{ years} \div 30 = 30 = 3 \times 10 \text{ generations.})$ So $1000 \times 1000 \times 1000 = 1\,000\,000\,000$ (in 1100.) (One billion)	B1	Allow 1 073 741 824 for using 1024 or 1×10^9	3	C
				[3]			
	(iii)	(A)	A curve going steeply from the top left and flattening out at the bottom right	B1		1	E
		(B)	Points $(1100, 10^9)$, $(1400, 10^6)$, $(1700, 10^3)$ and $(2000, 10^0)$	M1	Allow one error. May be implied by correct straight line.	1	A
			Straight line through the points	A1		2	A
				[3]			

Question			Answer	Marks	Guidance	AO	Diff											
	(iv)		It doesn't go off the scale It gives a straight line It is easier to work with a straight line	B1	Any sensible comment Allow more accurate, see more clearly (especially lower values), fit more data/easily on graph, can use large numbers.	4	A											
				[1]														
Question			Answer	Marks	Guidance	AO	Diff											
	(v)	<table border="1"><tr><td>Year (AD)</td><td>800</td><td>1100</td><td>1400</td><td>1700</td></tr><tr><td>Tom's ancestors (millions)</td><td>1 000 000</td><td>1000</td><td>1</td><td>0.001</td></tr></table> <p>Table 7.5</p>			Year (AD)	800	1100	1400	1700	Tom's ancestors (millions)	1 000 000	1000	1	0.001	B2	Allow 1 099 512,1 073, 1.048 for using 1024. Allow B1 for 1 mistake	3	A
Year (AD)	800	1100	1400	1700														
Tom's ancestors (millions)	1 000 000	1000	1	0.001														
		In the early years the number of Tom's living ancestors is greater than the number of people in the world at the time			B1		4	A										
		The assumption that all Tom's ancestors in any generation were all different people. (Relaxing this assumption would mean that the number of Tom's ancestors would not increase exponentially.)			B1		3	A										
					[4]													

Question			Answer	Marks	Guidance	AO	Diff
8	(i)		48 km = 48 000 OR 1 hour = 3600 seconds	M1	oe may be implied by division in next step.	1	E
			$\frac{48000}{3600} = 40/3 = 13 \frac{1}{3} \text{ (ms}^{-1}\text{)}$	A1	Units not required as given in question. Allow 13.3 or better. M1A1 for answer correct	1	E
				[2]			
	(ii)		Thinking distance = 9 m OR their 9 / 13 1/3 OR their 9 × 3600 / 48000	M1	For correct value (may be seen in division rather than stated explicitly) or operation	1	E
			Thinking time = $\frac{9}{13 \frac{1}{3}} = 0.675 \text{ s}$	A1	0.675 s given in question	2	C
			$112 \text{ km h}^{-1} = \frac{112000}{3600} \text{ m s}^{-1} (= 31 \frac{1}{9} \text{ m s}^{-1})$				
			$\frac{112000}{3600} \times 0.675 = 21 \text{ m, As required.}$ OR $21/31.111111... = 0.675 \text{ s}$ OR $21/0.675 = 31 \frac{1}{9}$	B1	For using $S \times T = D$ OR $D / S = T$ OR $D / T = S$ to verify thinking time = 0.675 s for second converted speed $31 \frac{1}{9} \text{ m s}^{-1}$.	4	A
				[3]			

Question			Answer			Marks	Guidance	AO	Diff
	(iii)					B1	Readings from 30 mph on diagram	1	E
	Speed in km/h		$v \text{ (ms}^{-1}\text{)}$	$d \text{ (m)}$	$b \text{ (m)}$				
	32		8.89	6	6				
	48		13.33	9	14				
	64		17.78	12	24	B1	Allow 26.6' or 26.66. Allow 26.6 from 96000 / 3600 (i.e. working seen)	1	E
	80		22.22	15	38				
	96		26.67	18	55				
	112		31.11	21	75				
						[2]			
	(iv)		$d = 0.675v$			B1	Allow 0.68 v	2	E
						[1]			

Question			Answer	Marks	Guidance	AO	Diff
	(v)		$14 = k \times \left(\frac{40}{3}\right)^2$ OR $14 = k \times (13.3')^2$ OR $14 = k \times (13 \frac{1}{3})^2$	M1	Allow $13.3'^2 = 177 \frac{7}{9}$ or $177.7'$ OR $13.3^2 = 176.89$ OR $13.33^2 = 177.6889$ in correct formula equal to 14 or rearranged version.	4	A
			$k = 0.07875$	A1	Accept 0.079(145231...) or better (from use of 13.3) OR 0.0788 or better (from using 13.33 to obtain 0.0787893897...)	2	A
				[2]			
	(vi)		$100 \text{ mph} = 160 \text{ km h}^{-1}$				
			$\Rightarrow v = \frac{160000}{3600} = 44.44 \text{ m s}^{-1} = 44 \frac{4}{9} \text{ m s}^{-1}$	B1	Allow 44.44(44...) or better	1	C
			$d = 0.675 \times 44.44 = 30 \text{ m}$	B1	Allow $d = 160 \div 5 \frac{1}{3}$ (factor includes conversion from km/h to m for previous B1 mark as well) OR 29.997 from use of 44.44	1	C
			$b = 0.07875 \times (44.44)^2 = 155.55 \text{ m}$	B1	Allow range 155 to 156	5	A
			$s = 185.55$ so 186 metres.	B1	Allow range 185 to 186.05	2	A
			NB Check 2 pages of Additional Answer Space. Use Fit Height to help.	[4]			

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