OCR
Oxford Cambridge and RSA

GCE

Mathematics (MEI)

Unit **4754A**: Applications of Advanced Mathematics: Paper A

Advanced GCE

Mark Scheme for June 2018

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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.

Annotations and abbreviations

Annotation in scoris	**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 in mark scheme	**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

Subject-specific Marking Instructions for GCE Mathematics (MEI) Pure 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, with 3 significant figures often being the norm. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. 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 For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate’s data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A mark in the question.

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

Question			Answer	Marks	Guidance
1			$\sin\theta - 2.4\cos\theta = R(\sin\theta\cos\alpha - \cos\theta\sin\alpha)$		Using θ for α can score 4/5 (so loses the A mark) but allow recovery
			$\Rightarrow R\cos\alpha = 1$, $R\sin\alpha = 2.4$	M1	Correct pairs – condone sign errors **only**
			$R^2 = 1^2 + 2.4^2 = 6.76 \Rightarrow R = 2.6$	B1	Allow $\sqrt{6.76}$ but not $\pm\sqrt{6.76}$ or ± 2.6 unless positive value chosen
			$\tan\alpha = 2.4$	M1	For M1 follow through their pairs (condone sign errors but division must be the correct way round)
			$\Rightarrow \alpha = 1.176$	A1	A1 for 1.18 or better, with no errors seen in either their method for α or for their pair of equations – A0 if in degrees
			Max value is 1 – (–2.6) = 3.6	B1	
					SC: If candidates state that $\cos\alpha = 1, \sin\alpha = 2.4 \Rightarrow \tan\alpha = 2.4$ this could score M0 B1 M1 A0 B1 (so max 3/5) Note that candidates who state the correct values of R and α with no (wrong) working seen can score full marks
				[5]	
2			$y = \ln x \Rightarrow x = e^y$	B1	Seen or implied
			$V = (\pi)\int_0^1 x^2\,dy = (\pi)\int_0^1 e^{2y}dy$	M1	Condone lack of π and limits for this mark (and dy throughout) – this mark can be awarded if left unsimplified e.g. $\int (e^y)^2\,dy$ or even for implying that the required integral is $\int e^{y^2}dy$ - M0 if rotation is about the x-axis
			$= \frac{1}{2}e^{2y}$	A1	Condone + c
			$= \left[\frac{1}{2}\pi e^{2y}\right]_0^1 = \frac{1}{2}\pi(e^2 - 1)$	A1	Exact (oe) – mark final answer (so no isw if correct answer is e.g. halved) but if exact answer seen and is then followed by 10.035… then this mark can be awarded
				[4]	

Question			Answer	Marks	Guidance
3			$\left(\frac{1}{(2-x)^3}=\right)k(1-\frac{1}{2}x)^{-3}$	B1	Their $k\neq 0$ (for reference the correct k is $\frac{1}{8}$)
			$=k[1+(-3)(-\frac{1}{2}x)+\frac{(-3)(-4)}{2!}(-\frac{1}{2}x)^2+...]$	M1*	All three correct **unsimplified** binomial coefficients (not left as nCr) i.e. 1, −3 and $\frac{(-3)(-4)}{2}$ (allow 2!). Or correct simplified coefficients seen
			$=k[1+\frac{3}{2}x+\frac{3}{2}x^2+...]$	A1ft	A1ft - correct simplified three-term expression with their k e.g. $k\left(1+\frac{3}{2}x+\frac{3}{2}x^2+...\right)$ **or** for $1+\frac{3}{2}x+\frac{3}{2}x^2+...$ seen
			$=\frac{1}{8}+\frac{3}{16}x+\frac{3}{16}x^2+...$	A1	Correct expansion of $\frac{1}{(2-x)^3}$ - allow with a factor of $\frac{1}{8}$
			$\frac{1+2x}{(2-x)^3}=(1+2x)[\frac{1}{8}+\frac{3}{16}x+\frac{3}{16}x^2+...]$	M1dep*	Multiplying out **correctly** (so multiplying (1 + 2x) by all three terms to obtain all relevant terms) for their three term expansion of $\frac{1}{(2-x)^3}$
			$=\frac{1}{8}+\frac{3}{16}x+\frac{3}{16}x^2+\frac{2}{8}x+\frac{6}{16}x^2+...$		
			$=\frac{1}{8}+\frac{7}{16}x+\frac{9}{16}x^2(+...)$ or $\frac{1}{8}\left(1+\frac{7}{2}x+\frac{9}{2}x^2(+...)\right)$	A1	www cao oe – ignore any higher order terms stated – do not isw after correct expansion seen if changed e.g. multiplying by 16
			valid for $\lvert x\rvert < 2$	B1	or $-2<x<2$, allow $-2<\lvert x\rvert<2$ but not say, $x<2$
				[7]	

Question			Answer	Marks	Guidance
4	(i)		$\frac{dx}{d\theta} = 2\cos 2\theta$, $\frac{dy}{d\theta} = 2\sin 2\theta - 2\sin\theta$	B1 B1	B1 for each
			$\frac{dy}{dx} = \frac{2\sin 2\theta - 2\sin\theta}{2\cos 2\theta}$	B1ft	Their $\frac{dy}{d\theta}$ divided by their $\frac{dx}{d\theta}$ - dependent on one previous B mark - isw after correct answer seen Note equivalent correct answers e.g. $\frac{\sin 2\theta - \sin\theta}{\cos 2\theta}$, $\tan 2\theta - \sin\theta \sec 2\theta$, etc.
				[3]	
4	(ii)		$2\sin 2\theta - 2\sin\theta = 0 \Rightarrow 4\sin\theta\cos\theta - 2\sin\theta = 0$	M1	Setting their numerator or $\frac{dy}{d\theta}$ or derivative equal to zero and use of correct double-angle formula(e) to remove all double angles – note that use of correct double-angle formula(e) may be seen in part (i)
			$\sin\theta(2\cos\theta - 1) = 0 \Rightarrow \theta = \pi/3$ or 60	A1	Condone additional solutions from either $\sin\theta = 0$ or $2\cos\theta - 1 = 0$ - ignore any mention of, or lack of consideration of $\sin\theta = 0$, condone $\theta = 60$
			$x = \sin 2\pi/3 = \sqrt{3}/2$	A1	Must be exact and simplified – condone if given as a decimal provided exact value seen – must come for correct working
			$y = 1 + 2\cos\pi/3 - \cos 2\pi/3 = 2\frac{1}{2}$	A1	Must be exact and simplified – must come from correct working If more than one answer given then award M1A1A1A0 max. **SC1**: B2 for $\sin\theta = \sin 2\theta \Rightarrow \theta = \pi/3$ and then B1 for *x* and B1 for *y* **SC2**: After M1 A1 award B1 for $y = \sqrt{3}/2$ and $x = 2\frac{1}{2}$ (unless recovered) provided no additional solutions
				[4]	

Question			Answer	Marks	Guidance
5	(i)		0.5×0.25	B1	For using 0.125 oe
			[0 + 1 +2(0.7603 + 0.9354 + 0.9922)] or $\left[0+1+2\left(\frac{\sqrt{37}}{8}+\frac{\sqrt{14}}{4}+\frac{3\sqrt{7}}{8}\right)\right]$	M1	The M mark requires the correct [...] bracket structure. It needs the first bracket to contain the first *y* value (if present must be zero but condone its absence) plus the last *y* value and the second bracket to be multiplied by 2 and to be the summation of the remaining *y* values with no additional values. Allow an error in one value **or** the omission of one value from the second bracket. M0 if using <u>all</u> *x* values. Candidates must be working to at least 2 decimal places
			0.797	A1 **[3]**	Must be given correct to 3 significant figures only (for reference 'correct' answer is 0.79697910…) Correct answer with no working is 0/3
5	(ii)		$A \approx ¼ \times \pi \times 1^2 = 0.785$	B1 **[1]**	Must be given correct to 3 significant figures only
5	(iii)		The <u>trapezium rule</u> estimate is <u>closer</u>, as it is an <u>under-estimate</u>, but is <u>greater</u> than the <u>quarter circle estimate</u>	B1 **[1]**	Must contain the fact that the trapezium rule which is an under-estimate of the area is closer to the true area as it is greater in value that the quarter-circle area This mark is dependent on both correct values to at least 3 sf seen in parts (i) **and** (ii)

Question			Answer	Marks	Guidance
6	(i)		(BC =) $h\tan\beta$	B1	BC and AC must be explicit expressions and not just seen as part of an equation/formula
			(AC =) $h\tan(\alpha+\beta)$	B1	
			So $x = h[\tan(\alpha+\beta)-\tan\beta] = h(\frac{\tan\alpha+\tan\beta}{1-\tan\alpha\tan\beta}-\tan\beta)$	M1*	Correct expansion of compound-angle formula for tan(*α* + *β*) seen
			$= h(\frac{\tan\alpha+\tan\beta}{1-\tan\alpha\tan\beta}-\frac{\tan\beta-\tan\alpha\tan^2\beta}{1-\tan\alpha\tan\beta})$ or $h(\frac{\tan\alpha+\tan\beta-\tan\beta(1-\tan\alpha\tan\beta)}{1-\tan\alpha\tan\beta})$	M1dep*	Either combining both fractions correctly or re-writing the second term with a denominator of $1-\tan\alpha\tan\beta$
			$= h\frac{\tan\alpha+\tan\alpha\tan^2\beta}{1-\tan\alpha\tan\beta} = \frac{h\tan\alpha(1+\tan^2\beta)}{1-\tan\alpha\tan\beta}$ $= \frac{h\tan\alpha\sec^2\beta}{1-\tan\alpha\tan\beta}$	A1	**NB AG –** www dependent on all previous marks – the identity $1+\tan^2\beta = \sec^2\beta$ need not be stated explicitly but the numerator must be factorised before the given result **or** by replacing $\tan^2\beta$ with $\sec^2\beta - 1$. Any incorrect working (even if recovered) loses this accuracy mark (as answer given)
				[5]	
6	(ii)		$h\left(\frac{\frac{4}{3}\tan\alpha}{1-\frac{\sqrt{3}}{3}\tan\alpha}\right) = h$	M1*	Correctly substituting of *x* = *h* (or *h* = *x*) and *β* = 30 – allow $h\left(\frac{1.33\tan\alpha}{1-0.577\tan\alpha}\right) = h$ or better. If 30 substituted correctly allow one error in the evaluation of $\tan 30$ **or** $\sec^2 30$
			$\frac{4}{3}\tan\alpha + \frac{\sqrt{3}}{3}\tan\alpha = 1$	M1dep*	Cancellation of *h* (or *x*) from both sides, cross-multiplying and re-arranging to get both terms in $\tan\alpha$ on the same side – allow 1.33 and 0.577
			α = 27.6°	A1	27.6 or better (degree symbol not required) – A0 for answer in radians - for reference 27.626340…
				[3]	**Alternative method:** B1 for $\text{BC} = h\tan 30$ M1 for $\tan(\alpha+30) = \frac{h+\text{BC}}{h}$ and their BC must contain *h* and tan30 A1 for 27.6

Question			Answer	Marks	Guidance
7	(i)		AB = $\sqrt{(2-1)^2+(1-(-3))^2+(1-(-1))^2}$ = √21	B1	Allow 4.58 or better (4.5825756…) – must be explicitly stated and not just as part of a scalar product
			AC = $\sqrt{(2-(-4))^2+(1-(-1))^2+(1-0)^2}$ = √41	B1	Allow 6.4(0) or better (6.4031242…) – must be explicitly stated and not just as part of a scalar product
			$\overrightarrow{AB}=\begin{pmatrix}-1\\-4\\-2\end{pmatrix}, \overrightarrow{AC}=\begin{pmatrix}-6\\-2\\-1\end{pmatrix} \Rightarrow \overrightarrow{AB}\cdot\overrightarrow{AC}=6+8+2(=16)$	B1	Correct product - allow full marks for using direction vectors BA and CA
			cos $\theta = \frac{16}{\sqrt{21}.\sqrt{41}}$	M1*	Must be using their vectors AB, BA, AC or CA only - correct use of scalar product by combining their values correctly including cosine, use of cosine rule is M0
			Angle BAC is 57.0 or 0.994	A1	www - allow 57 or better (for reference 56.956299…) – do not allow this mark for an answer which rounds to 56.9 – accept 0.994 or better (radians)
			Area = ½ × √21 × √41 sin 56.96	M1dep*	Correct use of area formula 0.5*ab* sin *C* with their values
			= 12.3	A1	www – for reference 12.298373… allow from 12.30444… (which comes from using 57) **SC**: If first method mark not awarded for use of cosine rule then award B1 for correct area **Please look carefully for candidates misreading (MR) the coordinates of A, B and/or C**
				[7]	

Question			Answer	Marks	Guidance
7	(ii)		$2+2\lambda=1-\mu$ $1+\lambda=-3+3\mu$ **or** $2+2\lambda=-4+4\nu$ $1-\lambda=-1+3\mu$ $1+\lambda=-1+\nu$ **or** $1-\mu=-4+4\nu$ $1-\lambda=2\nu$ $-3+3\mu=-1+\nu$ $-1+3\mu=2\nu$	B1	3 correct equations from the same set (i.e. in the same 2 unknowns) – note that the third equation may appear later, or with values already substituted. Note that this mark could be awarded when (some) candidates derive/show the coordinate of D by showing that two lines give the same coordinate when the values of the parameters are substituted into all three equations
			For first set of equations a value of λ or μ obtained from valid method (or equivalent parameters for second or third set)	M1	
			Two of $\lambda=-1$, $\mu=1$, $\nu=1$	A2	A1 for one correct value
			e.g. $1-(-1)=-1+3(1)$ oe	A1	Correct substitution into third equation (ie the one not used to find the two previous values) to verify that two of the lines meet (at D). In essence this mark is for verifying at some stage that two of the lines meet at a point by showing that all three equations with the correct two parameters are consistent
			e.g. $\mathbf{r}=\begin{pmatrix}-4\\-1\\0\end{pmatrix}+\nu\begin{pmatrix}4\\1\\2\end{pmatrix}=\begin{pmatrix}0\\0\\2\end{pmatrix}\Rightarrow\nu=1$	A1	Either using D(0,0,2) to find the third value of either λ,μ or ν for all three relevant equations (not just one) or solving a different set of equations and obtaining a different pair of $\lambda=-1$, $\mu=1$, $\nu=1$ and confirming that they meet at the same point. In essence this mark is for confirming that all three lines meet at the same point and therefore this mark is dependent on all previous marks Note that substituting all three correct values of the scalar parameters into all 3 sets of equations and obtaining the correct D (or showing that they are all equal) is acceptable and scores full marks **Note: no MRs in this part**
				[6]	

Question			Answer	Marks	Guidance
7	(iii)		(Normal is $\mathbf{r} =$) $\begin{pmatrix}0\\0\\2\end{pmatrix}+k\begin{pmatrix}0\\1\\-2\end{pmatrix}$	B1	Do not need to see **r** =… allow any scalar parameter for *k*
			$\begin{pmatrix}0\\k\\2-2k\end{pmatrix}\cdot\begin{pmatrix}0\\1\\-2\end{pmatrix}=-1\Rightarrow$ $k - 2(2 - 2k) = -1$	M1	Substitutes their equation of the normal (allow any position vector including zero/absent) into the plane and evaluate dot product – the direction vector of the normal though D to the plane must be correct and must contain a scalar parameter (allow any letter used) or $y - 2z = -1 \Rightarrow k - 2(2 - 2k) = -1$
			$\Rightarrow 5k = 3$, $k = 0.6$ $\Rightarrow$ E is (0, 0.6, 0.8)	A1	Condone stated as a position vector – mark final answer so no isw if multiplied by say 5
				[3]	
7	(iv)		DE = $\sqrt{(0.6^2 + 1.2^2)}$ (= 1.3416…)	B1	For reference D(0, 0, 2) and E(0, 0.6, 0.8) – www
			Volume of tetrahedron = (1.3416 × 12.3) /3	M1	Correct use of formula with their area from part (i)
			5.5	A1	Accept 5.5 or answers which round to 5.50
				[3]	
8	(i)		$\dfrac{1}{v(4+v^2)}=\dfrac{A}{v}+\dfrac{Bv+C}{4+v^2}$		
			$1 = A(4 + v^2) + (Bv + C)v$	B1	Seen or implied (allow recovery)
				M1	Cover up, substitution or equating coefficients – must be a complete method for finding one of *A*, *B* or *C*
			$v = 0 \Rightarrow 1 = 4A$, $A = ¼$	A1	www - these accuracy marks for the values of *A*, *B* or *C* must be checked carefully as it is possible to get these values correct with a variety of incorrect working
			coefficient of v^2: $0 = A + B \Rightarrow B = -¼$	A1	www
			coefficient of v: $0 = Cv \Rightarrow C = 0$	A1	www
				[5]	**Note that correct values for *A*, *B* and *C* from incorrect working will lose the subsequent A marks in (ii)**

Question			Answer	Marks	Guidance
8	(ii)		$\int \frac{\mathrm{d}v}{v(4+v^2)} = -\int k\,\mathrm{d}t$	M1*	Separating variables - condone sign slips and issues with placement/lack of of *k* but M0 for $\int v(4+v^2)\mathrm{d}v = ...$ or equivalent algebraic error in separating variables unless recovered. If no subsequent work integral signs needed, but allow omission of d*v* and/or d*t* but must be correctly placed if present
			For reference $\int [\frac{1}{4v} - \frac{v}{4(4+v^2)}]\mathrm{d}v = -kt + c$		
			$\int \frac{\lambda v}{(4+v^2)}\mathrm{d}v = \frac{\lambda}{2}\ln(4+v^2)$, $\int \frac{\mu}{v}\mathrm{d}v = \mu \ln v$	B1ft B1ft	Any non-zero λ, μ following through from their values in part (i) oe
			$\frac{1}{4}\ln v - \frac{1}{8}\ln(4+v^2) = -kt(+c)$	A1	oe (e.g. $\frac{1}{4}\ln 4v$) - do not condone invisible brackets e.g. ln $4 + v^2$ unless recovered later – condone absence of *c* (no follow through on this mark)
			when *t* = 0, *v* = 4 ⇒ *c* = ¼ ln 4 – 1/8 ln 20	M1dep*	Substituting $v = 4, t = 0$ correctly into each of their terms in an attempt to find their *c* (must get *c* = …)
			$\Rightarrow \frac{1}{8}\ln\frac{v^2}{4+v^2} = -kt - \frac{1}{8}\ln\frac{5}{4} \Rightarrow \ln\frac{v^2}{4+v^2} + \ln\frac{5}{4} = -8kt$ $\Rightarrow \ln\left(\frac{5v^2}{4(4+v^2)}\right) = -8kt$	M1	Correctly combines all their log terms (must include two log terms from integration and at least one from finding *c*) – dependent on all previous M marks. This mark can also be awarded for removing logs correctly from all terms. M0 if $C \neq 0$ from part (i)
			$\Rightarrow \frac{5v^2}{4(4+v^2)} = \mathrm{e}^{-8kt}$ or $\frac{v^2}{4+v^2} = \frac{4}{5}\mathrm{e}^{-8kt}$	A1	Correct equation (without logs)
			$\frac{4+v^2}{v^2} = \frac{5}{4}\mathrm{e}^{8kt} = \frac{4}{v^2} + 1$ $\Rightarrow \frac{4}{v^2} = \frac{5}{4}\mathrm{e}^{8kt} - 1 \Rightarrow \frac{v^2}{4} = \frac{4}{5\mathrm{e}^{8kt} - 4}$	M1	Correct method for making *v* or v^2 the subject– dependent on all previous M marks
			$\Rightarrow v^2 = \frac{16}{5\mathrm{e}^{8kt} - 4}$, $v = \frac{4}{\sqrt{5\mathrm{e}^{8kt} - 4}}$ *	A1	**AG –** all previous marks must have been awarded
				[9]	**PLEASE ENSURE THAT THE SECOND PAGE OF THIS PART IS CHECKED AND IF NOT USED IS ANNOTATED WITH BP**

Question			Answer	Marks	Guidance
8	(iii)		$2=\dfrac{4}{\sqrt{5e^{8k}-4}}$	B1	or correct equivalent e.g. $\ln\frac{4}{4+4}+\ln\frac{5}{4}=-8k$ - substitution of values may be seen later
			$\sqrt{5e^{8k}-4}=2 \Rightarrow 5e^{8k}=8 \Rightarrow e^{8k}=\dfrac{8}{5}$	M1	Correct method of getting e^{8k} equal to a non-zero constant (allow sign slips only or for $e^{8k}=\frac{5}{8}$ from $5e^{8k}=8$) or making *k* the subject
			$\Rightarrow k=\dfrac{1}{8}\ln\dfrac{8}{5}$ or 0.059	A1	Or exact equivalent e.g. $=-\frac{1}{8}\ln\frac{5}{8}$ - accept 0.059 or better
				[3]	

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