Pearson Edexcel

Mark Scheme

Mock Paper (Set 2)

December 2019

Pearson Edexcel GCE Mathematics

Pure Mathematics 2 Paper 9MA0/02

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 100.

2. The Edexcel Mathematics mark schemes use the following types of marks:
   - **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
   - **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
   - **B** marks are unconditional accuracy marks (independent of M marks)
   - Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes.

- bod – benefit of doubt
- ft – follow through
- the symbol $\surd$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- $\ast$ The answer is printed on the paper
- The second mark is dependent on gaining the first mark

4. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

5. Where a candidate has made multiple responses <u>and indicates which response they wish to submit</u>, examiners should mark this response.
   If there are several attempts at a question <u>which have not been crossed out</u>, examiners should mark the final answer which is the answer that is the <u>most complete</u>.

6. Ignore wrong working or incorrect statements following a correct answer.

7. Mark schemes will firstly show the solution judged to be the most common response expected from candidates. Where appropriate, alternatives answers are provided in the notes. If examiners are not sure if an answer is acceptable, they will check the mark scheme to see if an alternative answer is given for the method used.

General Principles for Further Pure Mathematics Marking

(*But note that specific mark schemes may sometimes override these general principles*)

<u>Method mark for solving 3 term quadratic:</u>

1. Factorisation

$(x^2+bx+c)=(x+p)(x+q)$, where $|pq|=|c|$, leading to $x=\ldots$

$(ax^2+bx+c)=(mx+p)(nx+q)$, where $|pq|=|c|$ and $|mn|=|a|$, leading to $x=\ldots$

2. Formula

Attempt to use the correct formula (with values for *a*, *b* and *c*)

3. Completing the square

Solving $x^2+bx+c=0$: $\left(x\pm\frac{b}{2}\right)^2\pm q\pm c=0,\quad q\neq 0$, leading to $x=\ldots$

<u>Method marks for differentiation and integration:</u>

1. Differentiation

Power of at least one term decreased by 1. $(x^n \rightarrow x^{n-1})$

2. Integration

Power of at least one term increased by 1. $(x^n \rightarrow x^{n+1})$

<u>Use of a formula</u>

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

Normal marking procedure is as follows:

<u>Method mark</u> for quoting a correct formula and attempting to use it, even if there are small errors in the substitution of values.

Where the formula is <u>not</u> quoted, the method mark can be gained by implication from <u>correct</u> working with values but may be lost if there is any mistake in the working.

<u>Exact answers</u>

Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.

Question	Scheme	Marks	AOs
1(a)	States or uses $2\log(3-x)=\log(3-x)^2$	B1	1.2
	$2\log(3-x)-\log(21-2x)=0 \quad \frac{(3-x)^2}{21-2x}=1$ oe	M1	1.1b
	$x^2-4x-12=0$ *	A1*	2.1
		(3)	
(b)	(i) $x=-2, 6$	B1	1.1b
	(ii) 6 is **not** a solution as $\log(3-6)$ cannot be found	B1	2.3
		(2)	
			(5 marks)

Notes:

(a)

B1: States or uses $2\log(2-x)=\log(2-x)^2$

M1: Correct attempt at eliminating the logs to form a quadratic equation in *x*.

An alternative method to the scheme is $2\log(3-x)=\log(21-2x)\Rightarrow(2-x)^2=21-2x$

A1*: Proceeds to the given answer with at least one line where the $(3-x)^2$ has been multiplied out.

There must be no errors or omissions.

(b)

B1: Writes down $x=-2, 6$

B1: Chooses 6 and gives a reason why it should be rejected, Eg. logs don't exist for negative numbers

Question	Scheme	Marks	AOs
2(a)	$f'(x) = 12x^3 + 4x - 12$	B1	1.1b
	Sets $f'(x) = 0 \Rightarrow x^3 = \dfrac{12-4x}{12}$	M1	1.1b
	$x = \sqrt[3]{1 - \dfrac{x}{3}}$ *	A1*	2.1
		(3)	
(b)	$x_2 = \sqrt[3]{1 - \dfrac{1}{3}}$	M1	1.1b
	$x_2 = 0.8736$	A1	1.1b
	$x_5 = 0.8894$	A1	1.1b
		(3)	
(c)	Attempts $f'(0.8885) = -0.029$ and $f'(0.8895) = 0.003$	M1	3.1a
	States that (1) there is a change of sign and (2) $f'(x)$ is continuous with the conclusion that $\alpha = 0.889$ to 3 dp	A1	2.4
		(2)	
			(8 marks)

Notes:

(a)

B1: Differentiates correctly $f'(x) = 12x^3 + 4x - 12$ Allow this when unsimplified.

M1: Attempts to set their $f'(x) = 0$ and proceeds to make x^3 the subject

A1*: Achieves $x = \sqrt[3]{1 - \dfrac{x}{3}}$ with no errors

(b)

M1: Attempts to use the iterative formula with $x_1 = 1$. This is implied by sight of $x_2 = \sqrt[3]{\dfrac{2}{3}}$ or awrt 0.87

A1: $x_2 = 0.8736$

A1: $x_5 = 0.8894$

(c)

M1: Attempts to substitute $x = 0.8885$ **and** $x = 0.8895$ into a suitable function and gets one value correct (rounded or truncated to 1 sf)

Suitable functions are e.g; $f'(x) = 12x^3 + 4x^2 - 12$, $g(x) = \pm\left(3x^3 + x^2 - 3\right)$ $h(x) = \pm\left(x - \sqrt[3]{1 - \dfrac{x}{3}}\right)$

A1: Requires

- both calculations to be correct (rounded or truncated to 1sf)
- a statement that the function is continuous (within the given interval)
- a correct conclusion, eg hence $\alpha = 0.889$ to 3 dp

Question	Scheme	Marks	AOs
3 (a)	Uses $s = r\theta = 9.2 \times 1.82 = 16.744$	M1	1.1b
	Correct method of finding angle *AFB* or *DFE* $\dfrac{\pi - 1.82}{2}$	M1	1.1b
	Correct method for *AB* or *DE* using a correctly found angle $(c^2) = 9.2^2 + 10.7^2 - 2 \times 9.2 \times 10.7 \cos \text{"}0.66\text{"}$	dM1	2.1
	Finds arc length *BCD* + two $\times AB$ +21.4 oe	M1	3.1a
	= 51.4 metres	A1	1.1b
		(5)	
(b)	Uses $A = \dfrac{1}{2}r^2\theta = \dfrac{1}{2} \times 9.2^2 \times 1.82 = 77.0224$	M1	1.1b
	Correct method for area of triangle *AFB* or *DEF* $\dfrac{1}{2} \times 10.7 \times 9.2 \times \sin\left(\dfrac{\pi - 1.82}{2}\right)$	M1	1.1b
	Finds area of sector *BFDC* + two triangles	dM1	3.1a
	= 137.4 m^2	A1	1.1b
		(4)	
			(9 marks)

Notes:

(a)

M1: Uses $s = r\theta = 9.2 \times 1.82$ This is implied by awrt 16.7

M1: Uses a correct method to find angle *AFB* or *DFE* This is implied by awrt 0.66 radians

dM1: Uses a correct method for *AB* or *DE* using a correctly found angle.

$(c^2) = 9.2^2 + 10.7^2 - 2 \times 9.2 \times 10.7 \cos \text{"}0.66\text{"}$

M1: Finds arc length *BCD* + two $\times AB$ +21.4 oe

A1: awrt 51.4 metres

(b)

M1: Uses $A = \dfrac{1}{2}r^2\theta = \dfrac{1}{2} \times 9.2^2 \times 1.82$ This is implied by awrt 77

M1: Uses a correct method for area of triangle *AFB* or *DEF* $\dfrac{1}{2} \times 10.7 \times 9.2 \times \sin\left(\dfrac{\pi - 1.82}{2}\right)$

dM1: Finds area of sector *BFDC* + two triangles

A1: awrt 137.4 m^2

Question	Scheme	Marks	AOs
4 (a)	Deduces that gradient of l_2 is $-\frac{1}{2}$	B1	2.2a
	Finding the equation of a line with gradient "$-\frac{1}{2}$" and point $(-2,3)$ $y-3=-\frac{1}{2}(x+2)$	M1	1.1b
	$y=-\frac{1}{2}x+2$	A1	1.1b
		(3)	
(b)	A point on l_1 is of the form $(x, 2x-1)$	B1	2.2a
	Uses the distance from $(x, 2x-1)$ to $(-2,3)$ is $2\sqrt{13}$ $(x+2)^2+(2x-4)^2=(2\sqrt{13})^2=52$	M1 A1	3.1a 1.1b
	$x^2+4x+4+4x^2-16x+16=52 \Rightarrow 5x^2-12x-32=0$ *	A1*	2.1
		(4)	
(c)	$5x^2-12x-32=0 \Rightarrow (5x+8)(x-4)=0$	M1	1.1b
	$x=-\frac{8}{5}, 4$	A1	1.1b
	Substitutes $x=-\frac{8}{5}$ into $y=2x-1$	M1	2.2a
	$B=\left(-\frac{8}{5}, -\frac{21}{5}\right)$	A1	1.1b
		(4)	
			(11 marks)

Notes:

(a)

B1: Uses the perpendicular rule to deduce that gradient of l_2 is $-\frac{1}{2}$

M1: Uses a changed gradient and $(-2,3)$ to find the equation of l_2. Look for $y-3=$ "$-\frac{1}{2}$"$(x+2)$

A1: $y=-\frac{1}{2}x+2$

(b)

B1: For deducing that *B* and *C* are of the form $(x, 2x-1)$. Scored when *y* is replaced by $(2x-1)$ when a simultaneous method is used.

M1: For using Pythagoras' theorem to set up an equation in *x*.

A1: For a correct unsimplified equation in *x*. $(x+2)^2+(2x-4)^2=52$

A1*: For correct algebra and working leading to the given answer $5x^2-12x-32=0$

(c)

M1: For a valid attempt to solve the given quadratic equation

A1: $x=-\frac{8}{5}, 4$ (You may ignore any reference to the 4)

M1: Substitutes their $x=-\frac{8}{5}$ into $y=2x-1$ and finds *y*

A1: $B=\left(-\frac{8}{5}, -\frac{21}{5}\right)$

Question	Scheme	Marks	AOs
5	Attempts to add $\overrightarrow{AB}$ and $\overrightarrow{BC}$ **AND** set equal to $k\times\begin{pmatrix}3\\-4\\3\end{pmatrix}$	M1	3.1a
	Correct equations $\begin{pmatrix}2p+q\\q-3p\\6\end{pmatrix}=k\begin{pmatrix}3\\-4\\3\end{pmatrix}$	A1	1.1b
	Deduces that $k=2$ OR $\overrightarrow{AB}+\overrightarrow{BC}=\begin{pmatrix}6\\-8\\6\end{pmatrix}$	A1	2.2a
	Sets up a pair of simultaneous equations from their $\overrightarrow{AB}+\overrightarrow{BC}=k\times\begin{pmatrix}3\\-4\\3\end{pmatrix}$ formula and attempts to solve their $\begin{matrix}2p+q=6\\q-3p=-8\end{matrix}$ to reach values for p and q	dM1	2.1
	$p=\frac{14}{5}, q=\frac{2}{5}$	A1	1.1b
		(5)	
			(5 marks)

Notes:

M1: Attempts to to add $\overrightarrow{AB}$ and $\overrightarrow{BC}$ **AND** set equal to $k\times\begin{pmatrix}3\\-4\\3\end{pmatrix}$

A1: For a correct statement. Eg $\begin{pmatrix}2p+q\\q-3p\\6\end{pmatrix}=k\begin{pmatrix}3\\-4\\3\end{pmatrix}$ This may be seen as three separate equations.

A1: Deduces that $k=2$

dM1: Sets up a pair of equations in p and q (dependent upon M1) and attempts to solve

A1: $p=\frac{14}{5}, q=\frac{2}{5}$

Question	Scheme	Marks	AOs
6 (a)	Translates problem into maths $12\,000 = 2600 + 9d \Rightarrow d = (1044.4)$	M1	3.1b
	Uses the AP model to find $2600 + "d"$	M1	3.4
	3 644 or 3 645 (batteries in Year 2)	A1	1.1b
		(3)	
(b)	Translates problem into maths $12\,000 = 2600 \times r^9 \Rightarrow r = (1.185)$	M1	3.1b
	Uses the GP model to find $2600 \times "r"$	M1	3.4
	awrt 3 080 (batteries in Year 2)	A1	1.1b
		(3)	
(c)	Correct attempt at one sum Either $\frac{10}{2}\{2\times 2600 + 9\times "1044"\}$ or $\frac{2600\left("1.185"^{10} - 1\right)}{"1.185" - 1}$	M1	1.1b
	Attempts both sums and subtracts either way around $\frac{10}{2}\{2\times 2600 + 9\times "1044"\} - \frac{2600\left("1.185"^{10} - 1\right)}{"1.185" - 1} = ...$	dM1	3.1a
	Accept 10 200 or 10 300 batteries	A1	1.1b
		(3)	
			(9 marks)

Notes:

(a)

M1: Attempts to use the AP model $12000 = 2600 + 9d$ to find a value for d

M1: Finds the number of batteries produced in year 2 by adding their value of d to 2600

A1: Calculates 3 644 or 3 645 (batteries in Year 2)

(b)

M1: Attempts to use the GP model $12000 = 2600r^9$ to find a value for r

M1: Finds the number of batteries produced in year 2 by multiplying their value of r by 2600

A1: Calculates awrt 3 080 (batteries in Year 2)

(c)

M1: Correct attempt at one of the sums using a correct equation and their values of d or r

Also accept $\frac{n}{2}\{a + l\} = \frac{10}{2}\{2600 + 12000\} = (73000)$

dM1: Correct attempt at the difference between both sums using correct equations and their values of d or r

A1: Accept 10 200 or 10 300 batteries depending upon accuracy used in (b)

Question	Scheme	Marks	AOs
7 (a)	$g\left(-\frac{1}{2}\right)=4\times-\frac{1}{8}+a\times\frac{1}{4}+4\times-\frac{1}{2}+b=0$ $(a+4b=10)$	M1	2.1
	$g''(x)=24x+2a$	B1	1.1b
	$g''\left(\frac{1}{6}\right)=4+2a=0$	M1	2.1
	Solves to find values for a and b	M1	3.1a
	$a=-2, b=3$	A1	1.1b
		(5)	
(b)	Finds $g'(x)=12x^2-4x+4$ for their value of a and attempts show that it cannot $=0$ e.g. $12x^2-4x+4=12\left(x-\frac{1}{6}\right)^2+\frac{11}{3}$	M1	3.1a
	For all x, $g'(x)>0$ Hence $g'(x)\neq 0$ so no stationary points.	A1	2.4
		(2)	
			(7 marks)

Notes:

(a)

M1: Identifies the fact that $(2x+1)$ is a factor to deduce that $g\left(-\frac{1}{2}\right)=4\times-\frac{1}{8}+a\times\frac{1}{4}+4\times-\frac{1}{2}+b=0$

B1: Differentiates twice to state (or use) $g''(x)=24x+2a$

M1: Identifies the fact that $y=g(x)$ has a point of inflection when $x=\frac{1}{6}$ to deduce that

$g''\left(\frac{1}{6}\right)=4+2a=0$

M1: A complete method to find values for a and b

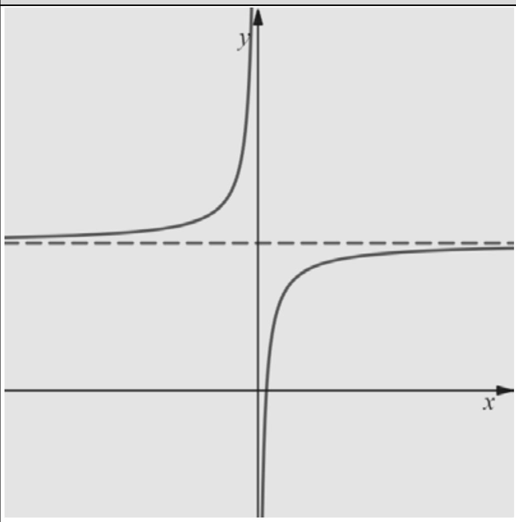
A1: $a=-2, b=3$

(b)

M1: Finds $g'(x)=12x^2-4x+4$ for their value of a and attempts show that it cannot $=0$

E.g. Attempts to show that $g'(x)>0$, or attempts to solve $g'(x)=0$

A1: For all x, $g'(x)>0$ Hence $g'(x)\neq 0$ so no stationary points.

Question	Scheme	Marks	AOs
8 (a)	 Shape	B1	1.1b
	Asymptote $y = k$	B1	1.1b
	Intercept $\left(\frac{1}{2k}, 0\right)$	B1	1.1b
		(3)	
(b)	Sets $k - \frac{1}{2x} = 2x + 3 \Rightarrow$ 3TQ	M1	3.1a
	$4x^2 + (6-2k)x + 1 = 0$	A1	1.1b
	Uses $b^2 - 4ac ... 0 \Rightarrow (6-2k)^2 - 16 ... 0 \Rightarrow k =$	M1	2.1
	Correct critical values $k = 1, 5$	A1	1.1b
	Selects outside region	M1	2.2a
	A correct range E.g. $\{k : k < 1\} \cup \{k : k > 5\}$	A1	2.5
		(6)	
		(9 marks)	

Notes:

(a)

See scheme

(b)

M1: For the key step of setting the equations equal to each other and proceeding to a 3TQ in x.

A1: For a correct 3TQ with the terms collected, which may be implied by correct values for a, b and c.

M1: Attempts to use the discriminant condition to find at least one critical value

A1: Correct critical values

M1: Selects the outside region

A1: Correct answer given in set notation.

E.g. $\{k : k < 1\} \cup \{k : k > 5\}$, $\{k \in \mathbb{R} : 0 < k < 1 \text{ or } k > 5\}$, $k \in (-\infty, 1) \cup (5, \infty)$

....

Alternative solution via differentiation: The first 3 marks may be awarded as follows.

M1: At the points where $y = 2x + 3$ is a tangent $\frac{\mathrm{d}}{\mathrm{d}x}\left(k - \frac{1}{2x}\right) = 2$ **A1:** $\frac{1}{2}x^{-2} = 2 \Rightarrow x = \pm\frac{1}{2}$

M1: Substitutes their $\left(\frac{1}{2}, 4\right)$ or $\left(-\frac{1}{2}, 2\right)$ into $y = k - \frac{1}{2x}$ to find at least one critical value.

Question	Scheme	Marks	AOs
9	Attempts to find the coordinates of *P*. It requires • an attempt to find $\frac{dy}{dx}$ • setting their $\frac{dy}{dx}=0$ to find a value for x • A value of y found from the value of x	M1	3.1a
	$y=xe^{-2x}\Rightarrow\frac{dy}{dx}=e^{-2x}-2xe^{-2x}$	B1	1.1b
	$\frac{dy}{dx}=0\Rightarrow(1-2x)e^{-2x}=0\Rightarrow x=\left(\frac{1}{2}\right)$	M1	1.1b
	So $P=\left(\frac{1}{2},\frac{1}{2e}\right)$ or $a=\frac{1}{2},b=\frac{1}{2e}$ oe	A1	2.1
		(4)	
	Attempts $\int xe^{-2x}dx=-\frac{1}{2}xe^{-2x}+\int\frac{1}{2}e^{-2x}dx$	M1	1.1b
	$=-\frac{1}{2}xe^{-2x}-\frac{1}{4}e^{-2x}$	dM1 A1	1.1b 1.1b
	Area $R=\frac{1}{2}\times\frac{1}{2e}-\left[-\frac{1}{2}xe^{-2x}-\frac{1}{4}e^{-2x}\right]_0^{\frac{1}{2}}$	M1	3.1a
	$=\frac{3}{4e}-\frac{1}{4}$ or $\frac{3-e}{4e}$	A1	2.1
		(5)	
			(9 marks)

Notes:

(a)

M1: This is an overall problem solving mark. See scheme on how to award.

B1: Uses the product rule to find $\frac{dy}{dx}=e^{-2x}-2xe^{-2x}$

M1: Scored for setting $\frac{dy}{dx}=e^{-2x}\pm kxe^{-2x}=0$ **and** finding x by either cancelling, or factorising out e^{-2x}

A1: Careful and rigorous work leading to an exact value for $P=\left(\frac{1}{2},\frac{1}{2e}\right)$ or $a=\frac{1}{2},b=\frac{1}{2e}$ oe

(b)

M1: For attempting to use integration by parts the correct way around.

Score for $\int xe^{-2x}dx=Axe^{-2x}+\int Be^{-2x}dx$

dM1: ....And integrates again to a correct form

A1: $\int x\mathrm{e}^{-2x}\mathrm{d}x = -\frac{1}{2}x\mathrm{e}^{-2x} - \frac{1}{4}\mathrm{e}^{-2x}$

M1: A problem solving mark for a complete correct strategy to find the area of R

A1: For careful and precise work leading to either $\frac{3}{4\mathrm{e}} - \frac{1}{4}$ or $\frac{3-\mathrm{e}}{4\mathrm{e}}$

Question	Scheme	Marks	AOs
10 (a)	Substitutes $t=0, H=20$ into $H=\dfrac{140}{A+45\sin 2t-28\cos 2t}$	M1	3.1b
	Full method to find A $\quad 20=\dfrac{140}{A-28} \Rightarrow A=...$	dM1	1.1b
	$H=\dfrac{140}{35+45\sin 2t-28\cos 2t}$	A1	3.3
		(3)	
(b)	$\tan\alpha=\dfrac{28}{45}$	M1	1.1b
	$\alpha=31.9$	A1	1.1b
		(2)	
	$H=\dfrac{140}{35+53\sin\left(2t-31.9\right)}$		
(c)	Obtains $H_{\min}=\dfrac{140}{"A"+53}$	M1	3.4
	1.59 metres or 159 cm	A1	1.1b
		(2)	
(d)	Sets $35+53\sin\left(2T_{\max}-31.9\right)=0$	M1	3.4
	The model is only valid for $\left(0\leqslant\right) T<126.6\text{ s}$	A1	3.5b
		(2)	
			(9 marks)

(a)

M1: Uses the given information to set an equation in *A*.

M1: Full method to find *A*.

A1: For writing out the equation of the model $H=\dfrac{140}{35+45\sin 2t-28\cos 2t}$

(b)

M1: For $\tan\alpha=\pm\dfrac{28}{45}$, $\tan\alpha=\pm\dfrac{45}{28}$, $\cos\alpha=\pm\dfrac{45}{53}$ or $\sin\alpha=\pm\dfrac{28}{53}$

A1: $\alpha=31.9$

(c)

M1: For using the model to obtain $H_{\min}=\dfrac{140}{"A"+53}$

A1: 1.59 metres or 159 cm

(d)

M1: For using the information to see that the model breaks down when $35 + 53\sin\left(2T_{\max} - 31.9\right) = 0$

A1: $T < 126.6$ s

Question	Scheme	Marks	AOs
11 (a)	Attempts $\int y\frac{\mathrm{d}x}{\mathrm{d}t}\,\mathrm{d}t=\int 2\tan t\times -6\sin 2t\,\mathrm{d}t$	M1 A1	1.2 1.1b
	Uses $\sin 2t = 2\sin t\cos t$ and $\tan t=\frac{\sin t}{\cos t}\Rightarrow\ -\int 24\sin^2 t\,\mathrm{d}t$	M1	2.1
	Area $R=\int_0^3 y\,\mathrm{d}x=-\int_{\frac{\pi}{4}}^{0}24\sin^2 t\,\mathrm{d}t=(+)\int_0^{\frac{\pi}{4}}24\sin^2 t\,\mathrm{d}t$ *	A1*	2.1
		(4)	
(b)	Uses $\cos 2t = 1-2\sin^2 t$ $\int 24\sin^2 t\,\mathrm{d}t=\int(12\cos 2t-12)\,\mathrm{d}t$	M1	2.1
	Integrates to form $=6\sin 2t-12t$ AND Uses the limits $t=0$ and $t=\frac{\pi}{4}$ either way around	M1	1.1b
	$=3\pi-6$	A1	2.1
		(7)	
			(7 marks)

Notes:

(a)

M1: Attempts $\int y\frac{\mathrm{d}x}{\mathrm{d}t}\,\mathrm{d}t=\pm A\int \tan t\times\sin 2t\,\mathrm{d}t$

A1: Correct expression for $\int y\frac{\mathrm{d}x}{\mathrm{d}t}\,\mathrm{d}t=\int 2\tan t\times -6\sin 2t\,\mathrm{d}t$

M1: Uses both $\sin 2t = 2\sin t\cos t$ and $\tan t=\frac{\sin t}{\cos t}\Rightarrow\ \pm\int C\sin^2 t\,\mathrm{d}t$

A1*: Rigorous proof with all aspects correct including the idea of the limits

(b)

M1: Attempts to use $\cos 2t = 1-2\sin^2 t\Rightarrow \int 24\sin^2 t\,\mathrm{d}t=\int\frac{C}{2}\cos 2t+\frac{C}{2}\,\mathrm{d}t$

M1: Integrates to the form $P\sin 2t+Qt$ **AND** uses limits $t=0$ and $t=\frac{\pi}{4}$ either way around

A1: Proceeds with rigorous and clear reasoning to $3\pi-6$ or $3(\pi-2)$

Question	Scheme	Marks	AOs
12 (a)	Sets $3\times 2^{2x}=96\sqrt{2}\Rightarrow 2^{2x}=32\sqrt{2}$	M1	1.1b
	$\Rightarrow 2^{2x}=2^5\times 2^{\frac{1}{2}}\Rightarrow 2x=5+\frac{1}{2}$	M1	2.1
	$\Rightarrow x=\frac{11}{4}$	A1	1.1b
		(3)	
(b)	Sets $6^{3-x}=3\times 2^{2x}$ and attempts to take logs with one correct law	M1	2.1
	$(3-x)\log 6=\log 3+2x\log 2$	A1	1.1b
	Takes $\log_2$ and uses $\log_2 6=\log_2 2+\log_2 3$ and $\log_2 2=1$	M1	2.1
	$(3-x)(\log_2 3+1)=\log_2 3+2x$ $\Rightarrow (2+1+\log_2 3)x=3\log_2 3+3-\log_2 3$	ddM1	1.1b
	$x=\dfrac{3+2\log_2 3}{3+\log_2 3}$ *	A1*	2.1
		(5)	
			(8 marks)

Notes:

(a)

M1: Sets $3\times 2^{2x}=96\sqrt{2}$ and proceeds to make 2^{2x} the subject

M1: Sets both sides as powers of 2 and proceeds to a linear equation in *x*. Alternatively takes logs of both sides and uses appropriate laws to proceeds to a linear equation in *x*

A1: $x=\frac{11}{4}$ or equivalent

....

$2^{2x}=32\sqrt{2}\Rightarrow 2x=\log_2 32\sqrt{2}\Rightarrow 2x=\frac{11}{2}$ only scores the first M1 unless clear reasoning is shown to explain the $\frac{11}{2}$. E.g. $2^{2x}=32\sqrt{2}\Rightarrow 2x=\log_2 32\sqrt{2}\Rightarrow 2x=\log_2\left(2^5\times 2^{\frac{1}{2}}\right)\Rightarrow 2x=\log_2\left(2^{\frac{11}{2}}\right)$

(b)

M1: Sets $6^{3-x}=3\times 2^{2x}$ and attempts to take logs with one correct law.

For example $\log 6^{3-x}=3-x\log 6$ would be condoned and allowed as an attempt

A1: For a correct linear equation in *x*. $(3-x)\log 6=\log 3+2x\log 2$

M1: The candidate must be seen to be taking $\log_2$'s and using both $\log_2 6=\log_2 2+\log_2 3$ and $\log_2 2=1$

ddM1: Dependent upon both M's, it is for an attempt to make *x* the subject.

A1*: Proceeds correctly to $x=\dfrac{3+2\log_2 3}{3+\log_2 3}$ showing correct intermediate steps

Question	Scheme	Marks	AOs
13	Assumption: There exists positive integers a and b such that $a+2b=\sqrt{8ab}$ and a is odd	B1	2.1
	$a+2b=\sqrt{8ab} \Rightarrow a^2+4ab+4b^2=8ab$ $\Rightarrow a^2-4ab+4b^2=0$	M1	1.1b
	Solving $\Rightarrow (a-2b)^2=0 \Rightarrow a=2b$	A1	3.1a
	This forms a contradiction as $a=2b$ means that a is even (since b is an integer). Hence the assumption is false and so the given statement is true	A1	2.4
		(4)	

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