CAMBRIDGE
International Education

Cambridge International AS & A Level

MATHEMATICS **9709/12**

Paper 1 Pure Mathematics 1 **October/November 2024**

MARK SCHEME

Maximum Mark: 75

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2024 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:
Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:
Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:
Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:
Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:
Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:
Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Mathematics Specific Marking Principles

1 Unless a particular method has been specified in the question, full marks may be awarded for any correct method. However, if a calculation is required then no marks will be awarded for a scale drawing.

2 Unless specified in the question, non-integer answers may be given as fractions, decimals or in standard form. Ignore superfluous zeros, provided that the degree of accuracy is not affected.

3 Allow alternative conventions for notation if used consistently throughout the paper, e.g. commas being used as decimal points.

4 Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored (isw).

5 Where a candidate has misread a number or sign in the question and used that value consistently throughout, provided that number does not alter the difficulty or the method required, award all marks earned and deduct just 1 A or B mark for the misread.

6 Recovery within working is allowed, e.g. a notation error in the working where the following line of working makes the candidate's intent clear.

Mark Scheme Notes

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

Types of mark

M Method mark, awarded for a valid method applied to the problem. Method marks are not 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, e.g. by substituting the relevant quantities into the formula. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.

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).

B Mark for a correct result or statement independent of method marks.

DM or **DB** When a part of a question has two or more 'method' steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly, when there are several B marks allocated. The notation DM or DB is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.

FT Implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only.

- A or B marks are given for correct work only (not for results obtained from incorrect working) unless follow through is allowed (see abbreviation FT above).
- For a numerical answer, allow the A or B mark if the answer is correct to 3 significant figures or would be correct to 3 significant figures if rounded (1 decimal place for angles in degrees).
- The total number of marks available for each question is shown at the bottom of the Marks column.
- Wrong or missing units in an answer should not result in loss of marks unless the guidance indicates otherwise.
- Square brackets [ ] around text or numbers show extra information not needed for the mark to be awarded.

Abbreviations

AEF/OE	Any Equivalent Form (of answer is equally acceptable) / Or Equivalent
AG	Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
CAO	Correct Answer Only (emphasising that no ‘follow through’ from a previous error is allowed)
CWO	Correct Working Only
ISW	Ignore Subsequent Working
SOI	Seen Or Implied
SC	Special Case (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)
WWW	Without Wrong Working
AWRT	Answer Which Rounds To

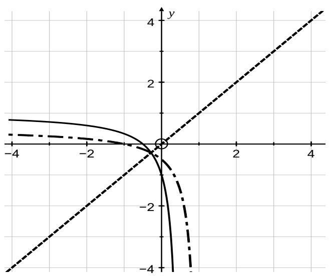
Question	Answer	Marks	Guidance
1(a)	$a=4$	B1	Allow $4\sin(2x)+3$ if values of *a*, *b* and *c* are not stated.
	$b=2$	B1	
	$c=3$	B1	
		3	
1(b)(i)	5	B1	Ignore attempts at finding solutions.
		1	
1(b)(ii)	1	B1	Ignore attempts at finding solutions.
		1	

Question	Answer	Marks	Guidance
2(a)	$\frac{20}{2}\left(2\times -20+\left(20-1\right)\times 5\right)$ or $\frac{20}{2}\left(-20+75\right)$	**M1**	Correct use of either S_{20} formula with a = –20 and d = 5.
	550	**A1**	
		2	
2(b)	$\frac{2k}{2}\left(-40+\left(2k-1\right)\times 5\right)$ or $\frac{k}{2}\left(-40+\left(k-1\right)\times 5\right)$	**M1***	Correct use of S_n formula with $a=-20$, $d=5$ and either k or $2k$. This mark can be awarded for clear use of $\frac{n}{2}\left(a+l\right)$ when correct values of a and d are used.
	$\left[-40k+10k^2-5k=-200k+25k^2-25k \Rightarrow\right] 15k^2-180k=0$	**DM1**	Equating their S_{2k} to 10 × *their* S_k and reaching a 2-term quadratic or 2 term linear equation if k has been cancelled. Condone errors in simplification.
	$k=12$	**A1**	Condone extra solution $k=0$.
		3	

Question	Answer	Marks	Guidance
3(a)	$\left[f(2+h)=\right]\ 2(2+h)^2-3$	**B1**	SOI
	$\dfrac{\left(2(2+h)^2-3\right)-5}{(2+h)-2}\quad\left[=\dfrac{2h^2+8h}{h}\right]$	**M1**	$\dfrac{\left\{their\left(2(2+h)^2-3\right)\right\}-their5}{(2+h)-2}$ can be implied by the simplified expression or the correct answer. *Their* 5 must come from $2(2)^2-3$.
	$2h+8$ or $2(h+4)$	**A1**	
		3	
3(b)	$h\to 0$, or chord [AB] $\to$ tangent [at A]	**B1**	Either of these statements or any sight of $h = 0$.
	8	**B1FT**	Could come from anywhere except wrong working. Either correct or FT their linear expression from **(a)**.
		2	

Question	Answer	Marks	Guidance
4(a)	15 or $\begin{pmatrix}6\\2\end{pmatrix}\times x^4\left(\dfrac{3}{x^2}\right)^2$ or $x^6\times\dfrac{6\times 5}{2}\left(\dfrac{3}{x^3}\right)^2$	**B1**	OE May be in a list. Allow $\begin{pmatrix}6\\4\end{pmatrix}$.
	135	**B1**	Correct term must be identified if in a list. Allow $135x^0$.
		2	

Question	Answer	Marks	Guidance
4(b)	20 or $\binom{6}{3}\times x^3\left(\frac{3}{x^2}\right)^3$ or $x^6\times\frac{6.5.4}{3!}\left(\frac{3}{x^3}\right)^3$	**B1**	OE May be in a list.
	$=\frac{540}{x^3}$	**B1**	Identifying $\frac{1}{x^3}$ term. This can be implied by sight of 2160 as part of the constant term.
	$4\times 540-5\times 135$	**M1**	$4\times \textit{their}\,540-5\times \textit{their}\,135$
	1485	**A1**	Allow $1485x^0$.
		4	

Question	Answer	Marks	Guidance
5(a)(i)	$\left[\mathrm{f}(-1)=\right]\ \frac{1}{3}$	**B1**	Condone 0.333.
		1	
5(a)(ii)		**B1**	For showing the correct mirror line.
		B1	For correct shape: the curves should intersect in the first square in the third quadrant. To the left of the point of intersection, the reflection is below the original and crosses the x-axis. To the right of the point of intersection, the reflection is to the right the original.
		2	

Question	Answer	Marks	Guidance
5(a)(iii)	$\frac{2x+1}{2x-1}=y \Rightarrow 2x+1=y(2x-1)$	M1*	Equating y to the given function and clearing of fractions. x and y may be interchanged at this stage.
	$2xy-2x=y+1$	DM1	Condone ± errors during simplification.
	$\frac{x+1}{2(x-1)}$, $\frac{-x-1}{2-2x}$	A1	Allow ‘ f^{-1} ’or ‘y =’ but NOT ‘x =’, nor fractions within fractions.
	[Domain of f^{-1} is] $x<1$	B1	Accept $-\infty < x < 1$ or $(-\infty, 1)$, condone $[-\infty, 1)$.
	Alternative Method for Question 5(a)(iii)		
	$y=1+\frac{2}{2x-1} \Rightarrow y-1=\frac{2}{2x-1}$	M1*	Equating y to the given function after division by $2x-1$. Isolating the term in x. x and y may be interchanged at this stage.
	$2x=\frac{2}{y-1}+1$	DM1	Condone ± errors during simplification.
	$\frac{1}{x-1}+\frac{1}{2}$	A1	OE Allow ‘ f^{-1} ’or ‘y =’ but NOT ‘x =’, nor fractions within fractions.
	[Domain of f^{-1} is] $x<1$	B1	Accept $-\infty < x < 1$ or $(-\infty, 1)$, condone $[-\infty, 1)$.
		4	

Question	Answer	Marks	Guidance
5(b)	$gf\left(\frac{1}{4}\right) = -7$	**B1**	
	$\frac{2x+1}{2x-1} = -7$	**M1**	Equating $\frac{2x+1}{2x-1}$ to *their* $gf\left(\frac{1}{4}\right)$.
	$[x =]\ \frac{3}{8}$	**A1**	OE
	Alternative solution for Question 5(b)		
	$gf\left(\frac{1}{4}\right) = -7$	**B1**	
	$x = f^{-1}(-7)$	**M1**	$x = f^{-1}\left(\textit{their } gf\left(\frac{1}{4}\right)\right)$
	$[x =]\ \frac{3}{8}$	**A1**	OE
		3	

Question	Answer	Marks	Guidance
6	[Perimeter =] $r+r\theta+r+2r\times 2\theta+r+r\theta+r$ $[=4r+6r\theta]$	B1	
	[Area =] $\frac{1}{2}r^2\theta+\frac{1}{2}(2r)^2\times 2\theta+\frac{1}{2}r^2\theta$ $[=5r^2\theta]$	B1	
	$4r+6r\theta=14$ and $5r^2\theta=10$	M1*	$ar+br\theta=14$ and $cr^2\theta=10$ where a, b and c are constants $\neq 0$. Terms may be uncollected.
	EITHER		
	$5r^2\frac{14-4r}{6r}=10$ or $4r+6r\left(\frac{10}{5r^2}\right)=14$	DM1	Eliminate θ to get an equation in r.
	$\left[\Rightarrow 2r^2-7r+6=0\Rightarrow\right]$ $(r-2)(2r-3)=0$	DM1	Factorise or other accepted method for solving their 3-term quadratic.
	OR		
	$5\left(\frac{14}{4+6\theta}\right)^2\theta=10$ or $4\left(\sqrt{\frac{10}{5\theta}}\right)+6\left(\sqrt{\frac{10}{5\theta}}\right)\theta=14$	DM1	Eliminate r to get an equation in θ.
	$[\Rightarrow 18\theta^2-25\theta+8=0\Rightarrow]$ $(9\theta-8)(2\theta-1)=0$	DM1	Factorise or other accepted method for solving their 3-term quadratic.
	Then		
	$r=2$ and $\theta=0.5$	B1	Condone extra answers $r=\frac{3}{2}$ and $\theta=\frac{8}{9}$.
		6	

Question	Answer	Marks	Guidance
7(a)	$-2\left((x \pm p)^2 \pm q\right)$ or $-2(x \pm p)^2 \pm q$	**M1***	$p \neq 0$.
	$-2\left((x-2)^2 \pm q\right)$ or $-2(x-2)^2 \pm q$	**DM1**	
	$-2(x-2)^2 + 19$ and (2, 19)	**A1**	Accept $x = 2, y = 19$ or 2, 19.
		3	

Question	Answer	Marks	Guidance
7(b)	**Method 1**		
	$\left[x=\right]\pm 1$	**B1***	Both x co-ordinates for the points of intersection.
	Subtract and attempt to integrate	**M1***	
	$\left[\int\left(-2x^2+2\right)\mathrm{d}x\right]-\frac{2}{3}x^3+2x$	**B1***	Both terms correct.
	$\left(-\frac{2}{3}+2\right)-\left(\frac{2}{3}-2\right)$	**M1**	Apply *their* limits, one positive and one negative, obtained from equating the line and the curve to their integrated expression.
	$=\frac{8}{3},\ 2\frac{2}{3}$	**DB1**	AWRT 2.67 WWW. Condone $\frac{-8}{3}\to\frac{8}{3}$. **SC B1** for mistaking triangle for trapezium leading to $\frac{11}{3}$, i.e. a total of 2/5.
	Method 2		
	$\left[x=\right]\pm 1$	**B1***	Both x co-ordinates for the points of intersection.
	Attempt to integrate and subtract	**M1***	The second integral can be replaced with what is clearly their area of a trapezium.
	$\left\{\frac{-2x^3}{3}+\frac{8}{2}x^2+11x\right\}[-]\left\{\frac{8}{2}x^2+9x\right\}$	**B1***	OE All terms correct. The second integral can be replaced by $\frac{1}{2}\left(1+17\right)\times 2$ OE.

Question	Answer	Marks	Guidance
7(b)	$\left\{\left(\frac{-2}{3}+4+11\right)-\left(\frac{2}{3}+4-11\right)\right\}$ [−] $\{(4+9)-(4-9)\}$	**M1**	Apply *their* limits, one positive and one negative, obtained from equating the line and the curve, to *their* integrated expressions. If the trapezium has been used, the second integral can be replaced by *their* 18.
	$=\frac{8}{3},\ 2\frac{2}{3}$	**DB1**	AWRT 2.67 WWW. Condone $\frac{-8}{3}\to\frac{8}{3}$. **SC B1** for mistaking triangle for trapezium leading to $\frac{11}{3}$, i.e. a total of 2/5.
	Method 3		
	$[x=]\pm 1$	**B1***	Both x co-ordinates for the points of intersection.
	Subtract and attempt to integrate	**M1***	
	$-\frac{2}{3}(x-2)^3-\frac{8}{2}x^2+10x$	**B1***	All terms correct.
	$\left(\frac{2}{3}-4+10\right)-(18-4-10)$	**M1**	Apply *their* limits, one positive and one negative, obtained from equating the line and the curve, to *their* integrated expression.
	$=\frac{8}{3},\ 2\frac{2}{3}$	**DB1**	AWRT 2.67 WWW.

Question	Answer	Marks	Guidance
7(b)	**Method 4**		
	$[x=]\pm 1$	**B1***	Both *x* co-ordinates for the points of intersection.
	Attempt to integrate and subtract	**M1***	The second integral can be replaced with what is clearly *their* area of a trapezium.
	$\left\{-\frac{2}{3}(x-2)^3+19x\right\}$ $[-]$ $\left\{\frac{8}{2}x^2+9x\right\}$	**B1***	All terms correct. The second integral can be replaced with $\frac{1}{2}(1+17)\times 2$ OE.
	$\left\{\left(\frac{2}{3}+19\right)-(18-19)\right\}$ $[-]$ $\{(4+9)-(4-9)\}$	**M1**	Apply *their* limits, one positive and one negative, obtained from equating the line and the curve, to *their* integrated expression. If the trapezium has been used the second integral can be replaced with *their* 18 OE.
	$=\frac{8}{3},\ 2\frac{2}{3}$	**DB1**	AWRT 2.67 WWW. Condone $\frac{-8}{3}\to\frac{8}{3}$. **SC B1** for mistaking triangle for trapezium leading to $\frac{11}{3}$, i.e. a total of 2/5.
		5	

Question	Answer	Marks	Guidance
8(a)	$\left(x-\left(-\frac{1}{2}p\right)\right)^2+\left(y-(-1)\right)^2$ OE	**B1***	Allow $a=-\frac{1}{2}p$ and $b=-1$, or centre is $\left(-\frac{1}{2}p,-1\right)$.
	$\left(x-\left(-\frac{1}{2}p\right)\right)^2+\left(y-(-1)\right)^2=-q+1+\left(-\frac{1}{2}P\right)^2$ OE	**DB1**	
		2	
8(b)(i)	[Gradient of tangent =] $-\frac{1}{2}$	**B1**	OE SOI
	[Gradient of normal =] 2	**M1**	Use of $m_1m_2=-1$with *their* numeric tangent gradient.
	$\frac{y-3}{x-4}=2$ $[y=2x-5]$	**A1**	OE ISW Allow $y=2x+c,\ 3=2\times4+c \Rightarrow c=-5$.
		3	

Question	Answer	Marks	Guidance
8(b)(ii)	**Method 1 for the first two marks:**		
	$-1-3=2\left(-\frac{1}{2}p-4\right)$ or $-1=-p-5$	**M1***	Using *their* stated centre or $\left(\frac{\pm p}{2},\ \pm 1\right)$ in *their* equation of the normal.
	$p=-4$	**A1**	
	Method 2 for the first two marks:		
	$-1=2x-5 \Rightarrow x=2 \Rightarrow -\frac{1}{2}p=2$	**M1***	Using their normal equation and *their* stated centre or $\left(\frac{\pm p}{2},\ \pm 1\right)$.
	$p=-4$	**A1**	
	Method 3 for the first two marks:		
	$2x+2y\frac{dy}{dx}+p+2\frac{dy}{dx}=0$ $\left[\Rightarrow p=-8-8\frac{dy}{dx}\right]$	**M1***	
	$\left[\frac{dy}{dx}=-\frac{1}{2}\Rightarrow\right]$ $p=-4$	**A1**	

Question	Answer	Marks	Guidance
8(b)(ii)	**Method 1 for the last 3 marks:**		
	$r^2 = (4-2)^2 + (3-(-1))^2$ $[=20]$	**M1***	Using (4, 3) and *their* centre or $\left(\frac{\pm their\ p}{2}, \pm 1\right)$ to find r^2 or r.
	$-q+1+\frac{1}{4}p^2 = 20$	**DM1**	OE Using *their* expression for r^2 (from **(a)**) equated to *their* 20.
	$q = -15$	**A1**	
	Method 2 for the last 3 marks:		
	$r = \frac{\lvert 2-2-10\rvert}{\sqrt{5}}$ $\left[=\frac{10}{\sqrt{5}}\right]$	**M1***	Using $(2,-1)$ and $x+2y-10=0$ (distance from a point to a line).
	$-q+1+\frac{1}{4}p^2 = \left(\frac{10}{\sqrt{5}}\right)^2$	**DM1**	OE Using *their* expression for r^2 equated to *their* $\left(\frac{10}{\sqrt{5}}\right)^2$.
	$q = -15$	**A1**	
	Method 3 for the last 3 marks:		
	$4^2+3^2+4p+6+q=0$ $[\Rightarrow\ 4p+q+31=0]$ OR $\left(4-\left(-\frac{1}{2}p\right)\right)^2+(3-(-1))^2 = -q+1+\left(-\frac{1}{2}p\right)^2$	**M1***	Substituting $(4,3)$ into their circle equation.
	$4(-4)+q+31=0$	**DM1**	Substituting *their* $p=-4$.
	$q = -15$	**A1**	

Question	Answer	Marks	Guidance
8(b)(ii)	**Alternative Method for Question 8(b)(ii)**		
	$4^2+3^2+4p+6+q=0$ $x^2+(2x-5)^2+px+2(2x-5)+q=0$ with $x=4$ $x^2+\left(\frac{10-x}{2}\right)^2+px+2\left(\frac{10-x}{2}\right)+q=0$ with $x=4$ $\left(\frac{y+5}{2}\right)^2+y^2+p\left(\frac{y+5}{2}\right)+2y+q=0$ with $y=3$ $(10-2y)^2+y^2+p(10-2y)+2y+q=0$ with $y=3$ $\{$Each of these $\Rightarrow 4p+q+31=0\}$	**M1***	Substituting $(4, 3)$ into *their* circle equation, or replacing y with $2x-5$ from the normal equation, or replacing y with $\frac{10-x}{2}$ from the tangent equation, or replacing x with $\frac{y+5}{2}$ from the normal equation, or replacing x with $10-2y$ from the tangent equation, and using either $x=4$ or $y=3$ to form an equation in p and q.
	$\frac{5}{4}x^2+(p-6)x+35+q=0 \Rightarrow (p-6)^2-4\times\frac{5}{4}\times(35+q)=0$ OR $5y^2-y(38+2p)+100+10p+q=0 \Rightarrow (38+2p)^2-4\times5\times(100+10p+q)=0$ $\{$Each of these $\Rightarrow p^2-12p-139-5q=0\}$	**M1***	Solving the tangent and circle equations simultaneously to form a quadratic equation in either x or y. Then using $b^2-4ac=0$ on their quadratic to form an equation in p and q.
	Solving the equations simultaneously to find p or q	**DM1**	
	$p=-4$	**A1**	
	$q=-15$	**A1**	
		5	

Question	Answer	Marks	Guidance
9(a)	$\left[\frac{1}{2}k^2 \times \frac{25}{4} - 2k \times \frac{5}{2} + 2 = \frac{1}{2}\right.$ OR $\left.\frac{1}{2}k^2 \times \frac{25}{4} - 2k \times \frac{5}{2} + 2 = k \times \frac{5}{2} + \left(\frac{1}{2} - \frac{5}{2}k\right)\right]$ $25k^2 - 40k + 12\ [=0]$	M1*	Using $\left(\frac{5}{2}, \frac{1}{2}\right)$ in the curve equation or equating the line and the curve and then using $x = \frac{5}{2}$ and $p = \frac{1}{2} - \frac{5}{2}k$. Simplify to get a three-term quadratic in *k*. Condone errors in simplification.
	$k = \frac{2}{5}$	A1	OE Condone inclusion of $k = \frac{6}{5}$.
	$\frac{1}{2} = \left(\textit{their}\ \frac{2}{5}\right)\left(\frac{5}{2}\right) + p \Rightarrow p =$	DM1*	Using $\left(\frac{5}{2}, \frac{1}{2}\right)$ and *their k* in an equation in *p*. Either the line (as shown) or $4p^2 + 12p + 5 = 0$ are the most likely and solving for *p*.
	$p = -\frac{1}{2}$	A1	OE Condone inclusion of $p = -\frac{5}{2}$.
	$\frac{2}{25}x^2 - \frac{6}{5}x + \frac{5}{2}\ [=0]\ \left[4x^2 - 60x + 125\ [=0]\right]$	DM1	Equating the line and curve using *their k* and *p* and simplify to get a three-term quadratic [= 0].
	$\left(\frac{25}{2}, \frac{9}{2}\right)$	A1 A1	OE Accept $x = \frac{25}{2}$, $y = \frac{9}{2}$.

Question	Answer	Marks	Guidance
9(a)	**Alternative Method for Question 9(a)**		
	$\left[\frac{1}{2}k^2\times\frac{25}{4}-2k\times\frac{5}{2}+2=\ k\times\frac{5}{2}+p\right]$ $4p^2+12p+5\ [=0]$	**M1***	OE Using $\left(\frac{5}{2},\ \frac{1}{2}\right)$ in the curve equation or equating the line and the curve and then using $x=\frac{5}{2}$ and $k=\frac{1}{5}-\frac{2}{5}p$. Simplify to get a three-term quadratic in p [= 0].
	$p=-\frac{1}{2}$ OE	**A1**	Condone inclusion of $p=-\frac{5}{2}$.
	$\frac{1}{2}=\left(\frac{5}{2}k\right)+\left(their-\frac{1}{2}\right)\ \Rightarrow k=$	**DM1***	Using $\left(\frac{5}{2},\ \frac{1}{2}\right)$ and *their* p in the line equation and solving for k.
	$k=\frac{2}{5}$	**A1**	OE Condone inclusion of $k=\frac{6}{5}$.
	$\frac{2}{25}x^2-\frac{6}{5}x+\frac{5}{2}[=0]\ \left[4x^2-60x+125[=0]\right]$	**DM1**	Equating the line and curve using *their* k and p and simplify to get a three-term quadratic [= 0].
	$\left(\frac{25}{2},\ \frac{9}{2}\right)$	**A1 A1**	OE Accept $x=\frac{25}{2}$, $y=\frac{9}{2}$.
		7	

Question	Answer	Marks	Guidance
9(b)	$\left[\frac{1}{2}k^2x^2 - 2kx + 2 = kx + p \Rightarrow\right] \frac{1}{2}k^2x^2 - 3kx + 2 - p$	M1*	Equate the original equations of the curve and the line and collect like terms; k and p must still be present.
	$9k^2 - 4\times\frac{1}{2}k^2(2-p)$	DM1	Use of $b^2 - 4ac$ for their quadratic in x to give an expression in k and p. This expression can come from *their* equation in **(a)**.
	$p < -\frac{5}{2}$	A1	
		3	

Question	Answer	Marks	Guidance
10(a)	–18	B1	SOI
	$\frac{1}{18}$	M1	Use of $m_1m_2 = -1$ from $f'(x)$ with $x = 1$.
	$\frac{y\ [-\ 0]}{x-1} = \frac{1}{18}$	A1	OE ISW
		3	

Question	Answer	Marks	Guidance
10(b)	$\left[\mathrm{f}(x)=\right]\left\{8(2x-3)^{\frac{4}{3}}.\frac{1}{2}.\frac{1}{\frac{4}{3}}\right\}\left\{-10x^{\frac{5}{3}}.\frac{1}{\frac{5}{3}}\right\}[+c]$ $\left[3(2x-3)^{\frac{4}{3}}-6x^{\frac{5}{3}}+c\right]$	B1B1	B1 for each unsimplified {}. Can be implied by equivalent simplified or partly simplified versions.
	$0=3(2(1)-3)^{\frac{4}{3}}-6(1)^{\frac{5}{3}}+c \quad [0=3-6+c]$	M1	Use of $x=1$ and $y=0$ in *their* integrated $f'(x)$, defined as an expression with at least one correct power, which must contain + c.
	$[f(x)$ or $y=]\ 3(2x-3)^{\frac{4}{3}}-6x^{\frac{5}{3}}+3$	A1	Only condone c = 3 as their final answer if all coefficients have previously been simplified in a correct statement.
		4	
10(c)	$b^2-4ac=128^2-4\times125\times192$ and stating "< 0" OR use of the quadratic formula and stating "No solutions" OR completing the square for the given quadratic and stating positive or > 0. OR sketch of the given quadratic and stating positive.	M1*	$b^2-4ac=-79616$ can be accepted in place of working.
	No turning points [in the original function.]	DM1	
	Decreasing because $f'(\text{any positive } x \text{ value})<0$	A1	WWW e.g. $f'(1)=-18$.
		3	