Paper 1 Section A

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2	B
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4	A
5	C
6	B
7	C
8	D
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Summary		
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Question	Generic Scheme	Illustrative Scheme	Max Mark
21(a).			
	•[1] know to use $x=1$	**Method 1** •[1] $1^3-6(1)^2+9(1)-4$	
	•[2] interpret result and state conclusion	•[2] $=0 \therefore (x-1)$ is a factor.	
		Method 2 •[1] $\begin{array}{c\|cccc} 1 & 1 & -6 & 9 & -4 \\ & & 1 & & \\ \hline & 1 & & & \end{array}$	
		•[2] $\begin{array}{c\|cccc} 1 & 1 & -6 & 9 & -4 \\ & & 1 & -5 & 4 \\ \hline & 1 & -5 & 4 & 0 \end{array}$ remainder $=0 \therefore (x-1)$ is a factor.	
		Method 3 •[1] $x-1 \overline{) x^3-6x^2+9x+4}$ with quotient x^2 and x^3-x^2	
		•[2] $=0 \therefore (x-1)$ is a factor.	
	•[3] state quadratic factor	•[3] x^2-5x+4 stated or implied by •[4]	
	•[4] factorise completely	•[4] $(x-1)^2(x-4)$	4

Notes:
1. Communication at $\bullet^2$ must be consistent with working at that stage i.e. a candidate's working must arrive legitimately at 0 before $\bullet^2$ is awarded. 2. Accept any of the following for $\bullet^2$: • '$f(1)=0$ so $(x-1)$ is a factor' • 'since remainder is 0, it is a factor' • the 0 from the table linked to the word 'factor' by e.g. 'so', 'hence', '$\therefore$', '$\rightarrow$', '$\Rightarrow$' 3. Do not accept any of the following for $\bullet^2$: • double underlining the zero or boxing the zero without comment • '$x=1$ is a factor', '$(x+1)$ is a factor', '$x=1$ is a root', '$(x+1)$ is a root', "$(x-1)$ is a root" • the word 'factor' **only,** with no link 4. At $\bullet^4$ the expression may be written as $(x-1)(x-1)(x-4)$ in any order. 5. An incorrect quadratic correctly factorised may gain $\bullet^4$. 6. Where the quadratic factor obtained is irreducible, candidates must clearly demonstrate that $b^2-4ac<0$ to gain $\bullet^4$. 7. $=0$ must appear at $\bullet^1$ or $\bullet^2$ for $\bullet^2$ to be awarded. 8. For candidates who do not arrive at 0 at the $\bullet^2$ stage $\bullet^2\bullet^3\bullet^4$ are not available. 9. Do not penalise candidates who attempt to solve a cubic equation. However, within this working there may be evidence of the correct factorisation of the cubic. 10. Evidence for $\bullet^3$&$\bullet^4$ may appear in part (b).
Commonly Observed Responses:

Question	Generic Scheme	Illustrative Scheme	Max Mark
21(b)(i).			
	•[5] know to and differentiate •[6] find gradient •[7] state equation of tangent	•[5] $3x^2 - 12x + 11$ •[6] 2 •[7] $y = 2x + 1$	**3**

Notes:

11. •[7] is only available if an attempt has been made to find the gradient from differentiation.
12. At mark •[7] accept $y - 3 = 2(x - 1)$, $y - 2x = 1$ or any other rearrangement of the equation.

Commonly Observed Responses:

Candidate A

•[5] ✓ •[6] ✓

using $y = mx + c$

$x = 1 \quad y = 3 \quad m = 2$

$\Rightarrow 3 = 2 \times 1 + c$

$\Rightarrow c = 1$ •[7] ✓

$y = 2x + 1$

Question	Generic Scheme	Illustrative Scheme	Max Mark
21(b)(ii).			
	•[8] set $y_{\text{CURVE}} = y_{\text{LINE}}$ •[9] arrange equation in standard cubic form •[10] identify x coordinate of B and calculate y coordinate	•[8] $x^3 - 6x^2 + 11x - 3 = 2x + 1$ •[9] $x^3 - 6x^2 + 9x - 4 = 0$ •[10] $(4, 9)$	**3**

Notes:

13. •[9] is only available if '$= 0$' appears in at least one arrangement of the equation.
14. Solutions at •[10] must be consistent with working at •[4] and •[7].
15. Candidates who obtain three distinct factors at •[4] can gain •[8] and •[9] but •[10] is unavailable.
16. For •[10] accept $x = 4, y = 9$.
17. Do not penalise the appearance of $(1, 3)$.

Commonly Observed Responses:

Question	Generic Scheme	Illustrative Scheme	Max Mark
22.			
	•[1] arrange in differentiable form	•[1] $f(x)=4x^{-2}+x$	
	•[2] start differentiation	•[2] $-8x^{-3}$ or 1	
	•[3] complete differentiation and set $f'(x)=0$	•[3] $-8x^{-3}+1=0$	
	•[4] evaluate f at stationary point	•[4] $x=2,\ f(x)=3$	
	•[5] consider end-points	•[5] $f(1)=5,\ \ f(4)=\frac{17}{4}$ (or $4\cdot25$)	
	•[6] state max and min values	•[6] $\max 5,\ \min 3$	6

Notes:

1. Candidates must attempt to differentiate a term with a -ve or fractional power by •[3] for •[3] to be awarded.
2. •[3] is not available for simply stating '$f'(x)=0$'. A clear link between the candidates derivative and '$f'(x)=0$' is required.
3. For candidates who integrate, but clearly believe they are finding the derivative •[1] •[4] •[5] •[6] are available (see CORs - K, L, and M). In other instances where candidates have integrated then only •[1] and •[5] are available. A numerical approach can only gain •[5].
4. •[5] and •[6] are not available to candidates who consider stationary points only.
5. Treat maximum $(1,5)$ and minimum $(2,3)$ as bad form.
6. Vertical marking is **not** applicable to •[5] and •[6].
7. The appearance of $(2,3)$ following any 2nd derivative or nature table gains •[4].
8. If at the •[4] stage a value of x is obtained outwith the given interval then •[4] is unavailable, but •[6] may still be gained (see CORs - F and G).
9. Candidates who consider the end values but do not evaluate the stationary value cannot gain •[6].

Commonly Observed Responses:

Candidate A	Candidate B	Candidate C	Candidate D
$f(x)=4x^{-2}+x$ $f'(x)=-8x^{-3}+1$ •[1] ✓ for stationary •[2] ✓ points $f'(x)=0$ •[3] ✓ **With no further working**	$f(x)=4x^{-2}+x$ •[1] ✓ •[2] ∧ for stationary points $f'(x)=0$ •[3] ∧ **With no further working**	$f(x)=4x^{-2}+x$ •[1] ✓ $f'(x)=-8x^{-3}+1$ •[2] ✓ for stationary •[3] ∧ points $\frac{dy}{dx}=0$ **With no further working**	$f(x)=4x^{-2}+x$ •[1] ✓ $-8x^{-3}+1$ •[2] ✓ for stationary •[3] ∧ points $f'(x)=0$ **With no further working**

Candidate E **Solely a numerical attempt** $f(1)=5,\ f(2)=3,$ $f(3)=\frac{31}{9},\ f(4)=\frac{17}{4}$ Award only $\bullet^5$ ✓ For any similar attempt which includes the evaluation of f for a value outwith the range award 0.	**Candidate F** $f(x)=4x^{-2}+x$ $f'(x)=8x..........$ $f'(x)=..........+1=0$ $x=-\frac{1}{8}\quad f(-\frac{1}{8})=255\frac{7}{8}$ $f(1)=5,\ f(4)=4\frac{1}{4}$ $\min\ 4\frac{1}{4},\ \max\ 255\frac{7}{8}$ $\bullet^1$ ✓ $\bullet^2$ ✗ $\bullet^3$ ✓ $\bullet^4$ [✓2] $\bullet^5$ ✓ $\bullet^6$ [✓1]	**Candidate G** $f(x)=4x^{-2}+x$ $f'(x)=-8x..........$ $f'(x)=..........+1=0$ $x=\frac{1}{8}\quad f(\frac{1}{8})=256\frac{1}{8}$ $f(1)=5,\ f(4)=4\frac{1}{4}$ $\min\ 4\frac{1}{4},\ \max\ 256\frac{1}{8}$ $\bullet^1$ ✓ $\bullet^2$ ✗ $\bullet^3$ ✓ $\bullet^4$ [✓2] $\bullet^5$ ✓ $\bullet^6$ [✓1]
Candidate H $f(x)=4x^{-2}+x$ $f'(x)=-8x^{-1}..........$ $f'(x)=..........+1=0$ $x=8\quad f(x)=8\frac{1}{16}$ $f(1)=5,\ f(4)=4\frac{1}{4}$ $\min\ 4\frac{1}{4},\ \max\ 8\frac{1}{16}$ $\bullet^1$ ✓ $\bullet^2$ ✗ $\bullet^3$ ✓ $\bullet^4$ [✓2] $\bullet^5$ ✓ $\bullet^6$ [✓1]	**Candidate I** $f(x)=4+x^3$ $f'(x)=0+3x^2=0$ $x=0\quad f(x)=\text{undefined}$ $\bullet^1$ ✗ $\bullet^2$ ✗ $\bullet^3$ [✓2] $\bullet^4$ ✗ $\bullet^5$ ^ $\bullet^6$ ^	**Candidate J** $f'(x)=\frac{4}{x^2}+x=0$ $f(1)=5,\ f(4)=4\frac{1}{4}$ $\bullet^1$ ✗ $\bullet^2$ ✗ $\bullet^3$ ✗ $\bullet^4$ ✗ $\bullet^5$ ✓ $\bullet^6$ ^
Candidate K $f(x)=4x^{-2}+x$ $f'(x)=-4x^{-1}+\frac{x^2}{2}$ $x=2\quad f(2)=3$ $f(1)=5,\ f(4)=4\frac{1}{4}$ $\min\ 3,\ \max\ 5$ $\bullet^1$ ✓ $\bullet^2$ ✗ $\bullet^3$ ✗ $\bullet^4$ [✓1] $\bullet^5$ ✓ $\bullet^6$ [✓1]	**Candidate L** $f(x)=4x^{-2}+x$ $\int 4x^{-2}+x=-4x^{-1}+\frac{x^2}{2}=0$ $x=2\quad f(2)=3$ $f(1)=5,\ f(4)=4\frac{1}{4}$ $\min\ 3,\ \max\ 5$ $\bullet^1$ ✓ $\bullet^2$ ✗ $\bullet^3$ ✗ $\bullet^4$ ✗ $\bullet^5$ ✓ $\bullet^6$ ✗	**Candidate M** $4x^{-2}+x$ $-4x^{-1}+\frac{x^2}{2}=0$ $x=2\quad f(2)=3$ $f(1)=5,\ f(4)=4\frac{1}{4}$ $\min\ 3,\ \max\ 5$ $\bullet^1$ ✓ $\bullet^2$ ✗ $\bullet^3$ ✗ $\bullet^4$ ✗ $\bullet^5$ ✓ $\bullet^6$ ✗

Question	Generic Scheme	Illustrative Scheme	Max Mark
23.			
	•[1] collect log terms •[2] use laws of logs •[3] use laws of logs •[4] solve for x	**Method 1** •[1] $\log_2(3x+7)-\log_2(x-1)=3$ **stated or implied by •[2]** •[2] $\log_2\frac{(3x+7)}{(x-1)}=3$ •[3] $\frac{(3x+7)}{(x-1)}=2^3$ •[4] $x=3$ **Method 2** •[1] $\log_2(3x+7)=3\log_2 2+\log_2(x-1)$ **stated or implied by •[2]** •[2] $\log_2(3x+7)=\log_2 2^3+\log_2(x-1)$ •[3] $\log_2(3x+7)=\log_2 8(x-1)$ •[4] $x=3$	4

Notes:

1. For •[3] accept $\log_2\frac{(3x+7)}{(x-1)}=\log_2 8$.

Commonly Observed Responses:

Candidate A	Candidate B
$\log_2(3x+7)=3+\log_2(x-1)$ $-3=\log_2(x-1)-\log_2(3x+7)$ •[1] ✓ $-3=\log_2\frac{x-1}{3x+7}$ •[2] ✓ $\frac{x-1}{3x+7}=2^{-3}$ •[3] ✓ $8x-8=3x+7$ •[4] ✓ $x=3$	$\log_2(3x+7)=3+\log_2(x-1)$ $\log_2(3x+7)+\log_2(x-1)=3$ •[1] ✗ $\log_2(3x+7)(x-1)=3$ •[2] ✓ $(3x+7)(x-1)=2^3$ •[3] ✓ $3x^2+4x-15=0$ •[4] ✓ $(3x-5)(x+3)=0$ $x=\frac{5}{3}$ or $x=-3$ discard as $x>1$ $x=\frac{5}{3}$ •[4] is not available for candidates who do not discard $x=-3$

Question	Generic Scheme	Illustrative Scheme	Max Mark
24.			
	•¹ interpret the values of *a*, *b* and *c* and substitute	•¹ $3^2 - 4 \times k \times 9k$	
	•² know to use discriminant ≥ 0	•² $.... \geq 0$	
	Method 1	**Method 1**	
	•³ simplify or factorise quadratic inequation	•³ $k^2 \leq \frac{9}{36}$ or $9(1-2k)(1+2k) \geq 0$	
	•⁴ state range of values of *k*	•⁴ $-\frac{1}{2} \leq k \leq \frac{1}{2}$	
	Method 2	**Method 2**	
	•³ simplify or factorise quadratic expression	•³ $9 - 36k^2 = 0 \Rightarrow k = -\frac{1}{2}, \frac{1}{2}$	
	•⁴ evidence and range of values of *k*	•⁴ graph or other evidence leading to $-\frac{1}{2} \leq k \leq \frac{1}{2}$	4

Notes:

1. The "≥ 0" must appear at least once at the •¹ or •² stage for •² to be awarded.
2. If an x appears in the candidate's 'discriminant' only •² may be awarded.
3. The use of any expression masquerading as the discriminant can gain only •² at most.
4. Award •² to candidates who write **BOTH** $9 - 36k^2 > 0$ **AND** $9 - 36k^2 = 0$.
5. For candidates who at •³ simplify or factorise an equation •⁴ can only be awarded if evidence of solving an inequation (for example a graph) appears.
6. At •² stage, quoting $b^2 - 4ac \geq 0$ is not sufficient.
7. At •³ stage, in Method 2, solutions for k need not be simplified.

Commonly Observed Responses:

Question	Generic Scheme	Illustrative Scheme	Max Mark
25(a)			
	•[1] know to use Theorem of Pythagoras' or distance formula	•[1] $D=\sqrt{(2t-5)^2+(t-10)^2}$	
	•[2] process to obtain result	•[2] $D=\sqrt{4t^2-20t+25+t^2-20t+100}$ $=\sqrt{5t^2-40t+125}$	2

Notes:

Be wary of fudged solutions!

Commonly Observed Responses:

Candidate A	Beware
$D^2=(y_2-y_1)^2+(x_2-x_1)^2$ $D=\sqrt{((2t-5)+0)^2+(0+(t-10))^2}$ •[1] × $D=\sqrt{5t^2-40t+125}$ •[2] × **See note 12 in the general instructions**	$A(2t-5,0)\ B(0,t-10)$ •[1] × $\overrightarrow{AB}=\begin{pmatrix}0\\t-10\end{pmatrix}-\begin{pmatrix}2t-5\\0\end{pmatrix}=\begin{pmatrix}2t-5\\t-10\end{pmatrix}$ •[2] ✓1 $D=\sqrt{(2t-5)^2+(t-10)^2}$ $D=\sqrt{4t^2+t^2-20t-20t+25+100}$ $D=\sqrt{5t^2-40t+125}$ **NB: This is an exception to note 12 in the general instructions**

Question	Generic Scheme	Illustrative Scheme	Max Mark
25(b)			
	•[3] write in differentiable form	•[3] $\left(5t^2-40t+125\right)^{\frac{1}{2}}$	
	•[4] start differentiation	•[4] $\frac{1}{2}\left(5t^2-40t+125\right)^{-\frac{1}{2}}$	
	•[5] complete differentiation	•[5] $.....\times(10t-40)$	
	•[6] substitute t = 5 and interpret result	•[6] $D'(5)=\frac{10}{2\sqrt{50}}>0\ \therefore \text{increasing}$	4

Notes:

1. •[4] is only available for differentiating an expression of the form $(\text{trinomial})^{\text{proper fraction}}$.
2. Do not penalise the use of x instead of t.
3. •[6] is only available to candidates who substitute into a derivative.

Commonly Observed Responses:

Candidate A

$D(t) = \left(5t^2 - 40t + 125\right)^{-1}$

$D'(t) = -\left(5t^2 - 40t + 125\right)^{-2} \ldots$

$= \ldots\ldots \times (10t - 40)$

$D'(5) = \dfrac{-10}{50^2} < 0 \therefore$ decreasing

•3 ✗
•4 ✗ see note 1.
•5 ✓
•6 ✓1

Candidate B

$D(t) = \left(5t^2 - 40t + 125\right)^{-\frac{1}{2}}$

$D'(t) = -\dfrac{1}{2}\left(5t^2 - 40t + 125\right)^{-\frac{3}{2}} \ldots$

$= \ldots\ldots \times (10t - 40)$

$D'(5) = \dfrac{-5}{\sqrt{50^3}} < 0 \therefore$ decreasing

•3 ✗
•4 ✓1
•5 ✓
•6 ✓1

Candidate C

$D(t) = \left(5t^2 - 40t + 125\right)^{\frac{1}{2}}$

$D'(t) = \dfrac{1}{2}\left(5t^2 - 40t + 125\right)^{\frac{3}{2}} \ldots$

$= \ldots\ldots \times (10t - 40)$

$D'(5) = 5\sqrt{50^3} > 0 \therefore$ increasing

•3 ✓
•4 ✗
•5 ✓
•6 ✓1

Candidate D

$D(t) = \left(5t^2 - 40t + 125\right)^{\frac{1}{2}}$

$D'(t) = \dfrac{1}{2}\left(5t^2 - 40t + 125\right)^{-\frac{1}{2}} \times 10t - 40$

$D'(t) = 5t\left(5t^2 - 40t + 125\right)^{-\frac{1}{2}} - 40$

$D'(5) = \dfrac{25}{\sqrt{50}} - 40 < 0 \therefore$ decreasing

•3 ✓
•4 ✓
•5 ✗
•6 ✓1

Candidate E

$D(t) = \left(5t^2 - 40t + 125\right)^{\frac{1}{2}}$

$D'(t) = \dfrac{1}{2}\left(5t^2 - 40t + 125\right)^{-\frac{1}{2}} \times 10t - 40$

$D'(5) = \dfrac{1}{\sqrt{2}} > 0 \;\therefore$ increasing

•3 ✓
•4 ✓
•5 ✓
•6 ✓

Candidate F - Alternative Method

$D^2 = 5t^2 - 40t + 125$

$\dfrac{dD^2}{dt} = 10t - 40$

$t = 5 \Rightarrow \dfrac{dD^2}{dt} = 50 - 40$

$\dfrac{dD^2}{dt} = 10 > 0 \quad \therefore D^2$ is increasing

$\therefore$ D is increasing

•3 ✓
•4 ✓
•5 ✓
•6 ✓

Calculating Distance

$t = 5 \quad D = \sqrt{50}$

$t = 4 \quad D = \sqrt{45}$

so distance is increasing

•3 ✓2
•4 ✗
•5 ✗
•6 ✗

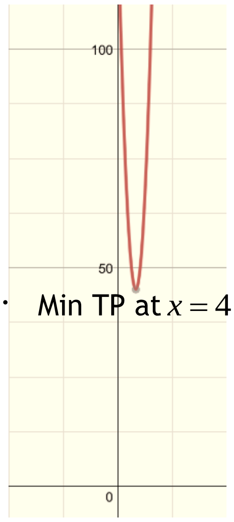
Award 0 marks as answer is not from differentiation.

Alternative Response

$D^2 = 5(t^2 - 8t + 25)$

$D^2 = 5[(t-4)^2 + 9]$

Graph together with a statement indicating that when $t = 5$, D^2 is increasing and therefore D is increasing.



Min TP at $x = 4$

•3 ✓
•4 ✓
•5 ✓
•6 ✓